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The Institute of Vitreous Enamellers

The Welsh Engineers' and Founders' Association

The Foundry Trades' Equipment and Supplies Association

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The New Order

Foundry owners, like most human beings, give but scant attention to official orders and forms. It is usual to wait until a "second application" is made, but now that a war is in progress it is essential that meticulous attention be given to these orders. In our issue of September 7, on page 178, we published a lengthy extract containing the essential provisions of the Control of Iron and Steel Order, 1939, dated September 1. Divested of legal jargon, this order stipulates that the iron and steel foundries cannot buy pig-iron, scrap and ferro-alloys (with certain exceptions), nor can they sell castings, without a licence, unless they are making castings for the defence services, or other Government departments, civil defence, and A.R.P., railway companies, shipbuilders and the like, collieries, and for orders placed before September 1. Whilst scrap iron and steel is scheduled, it can be supplied and received for the time being without a licence. Licences for iron foundries are dealt with by the department of the Controller of Iron Castings, at Steel House, Tothill Street, London, S.W.1. Sir Andrew Duncan has appointed Mr. Charles W. Bigg as the Controller of Iron Castings. Mr. Bigg is well known in the industry as works director of Qualcast, Limited, and because he presided with outstanding distinction over the Institute of British Foundrymen just two years ago. He is assisted by Mr. W. R. Blair, the director of the British Ironfounders' Association, an organisation which has for several years controlled the selling of builders' castings. Already a number of regional directors have been appointed, and further appointments will be announced in the very near future. The appointment of Mr. Bigg has been well received by the industry, as he is not only a practical foundryman, and a director of one of the most successful foundry concerns in the country, but an organiser of the highest calibre.

The order to which we have made reference is not the only one which requires the careful and personal attention of responsible foundry executives. There are several others, such as compulsory insurance of certain stocks, labour dilution, and the retention of skilled operatives. For the non-ferrous foundry, licences are required for the purchase of most of the raw materials, but the selling position seems to be rather nebulous. Light alloy castings are being controlled in practice.

The technical institutes are free from any restrictions except in so far as meetings are concerned. Here the situation is covered by the Order regulating public meetings, a situation which has been eased since the outbreak of war. The policy of the various Branches differs; some are continuing normally, others are undecided, whilst a few have decided to cancel the winter programme. Several of the Branches have suggested that authors should continue with the preparation of their Papers and send them to the FOUNDRY TRADE JOURNAL to be credited to the Branch where presentation should have been effected. By this means a continuity would be established and the industry through the Institute would continue to benefit from its admirable organisation. It is our firm belief that, if conditions are at all possible, the regular monthly meetings should be held, as, apart from the JOURNAL, they afford the only means of acquiring the news, both technical and social, of the industry. Moreover, such meetings help the industry with the interpretations of the new orders. Under war-time conditions, we think it advisable for a system to be instituted whereby queries referring to technical difficulties could be handed up to the chairman to be answered publicly or privately at the discretion of the inquirer. It will be but seldom that any question need be regarded as confidential from the national point of view, but individuals may not care to let it be known that difficulties have arisen.

So far as the general committee work of the Institute of British Foundrymen is concerned, immediate meetings have been cancelled, and a decision will be taken within the course of the next few weeks as to future policy.

The reduced transport facilities and compulsory black-out must not indefinitely allow the cessation of all technical and semi-social activities. The extinction of the entertainment industry was quickly found to be undesirable, and if this be the case, surely cultural activities should be continued if at all possible?

C

Metals in Wartime

By "ONLOOKER."

Immediately on the outbreak of war control of non-ferrous metals was instituted, but in the first place tin was omitted, only to be brought in later when the price began to sky-rocket in New York. On the Metal Exchange dealings have been suspended with the exception of some trading in tin, which was, however, interrupted for a few days by the decision to include this metal under the control. September has seen a sharp upward movement in metal prices in the United States, where the quotation for domestic copper advanced rapidly to 12½ cents, but reacted to 12 cents with the export figure at 11.75 cents c.i.f. European port. The parity on this side of such a price level would mean copper in the sixties, but the Control has taken a firm grip on the situation, as a result of which users of copper are able to cover their needs at a high limit of £51 c.i.f. for electro, £49 10s. for best selected, and £46 for blister.

In the light of what happened in the period 1914/18 it must be admitted that consumers of copper have every reason to feel pleased that on this occasion it has proved possible to keep values within bounds which nobody can say are not eminently reasonable, especially in the light of present-day events.

Obviously no guarantee can be given that these official maximum prices will not be exceeded, but the opinion is gaining ground that we are in for a period of stability and that even if an advance is made it will not be serious. Foreign lead is fixed at £16 12s. 6d. c.i.f. U.K. ports, and Empire brands at £17 c.i.f., while spelter stands at £15 c.i.f. for G.O.B. and £18 for high grade. Here, again, if a comparison is to be made with American values, we find that 6 cents returns a parity well above the high limit fixed by the Non-ferrous Control. Since the war began there have been reasons for the voicing of adverse criticisms, but in regard to the values placed on non-ferrous metals there can be nothing but praise, at any rate from the consumers' point of view.

Steady Market Assured

There certainly was a suggestion, understood to emanate from Metal Exchange sources, that the values fixed are too low, and certainly so far it does not seem to have been possible to clear up outstanding prompts which have fallen due since war began. Conversations between the Committee of the Exchange and the authorities are said to be proceeding, and doubtless these points will be cleared up in due course. In the meanwhile the need for hedging is diminished through the fact that, with control in force, stability has been achieved and holders are relieved of anxiety on the score of market fluctuations.

The explanation of the ability of the control to keep values within such reasonable bounds and so much under the American parity lies in the fact that the past two decades have seen a marked development in Empire resources of non-ferrous metals. According to statistics, last year's production of Canadian copper were some 260,000 tons and that of Rhodesia about 210,000 tons, so that we shall not fare too badly by depending on Empire metal. In lead, Canada, Australia and Burma between them produced more than half a million tons last year, and there is also the modest tonnage from Newfoundland and from this country. In spelter Canada can furnish about 150,000 tons and Australia nearly half that quantity, while this country is now producing some 5,000 tons monthly. This gives a total of about 280,000 tons, which is certainly not so high as lead, but which ought to be enough to see the situation through.

Tinning Cast Iron

By W.P.

It is unusual for the foundry specially to prepare castings for the specific purpose of taking a tinned coating. Usually they enter into the general classification of machinery castings, and are of a weight and size which can be handled with either tongs or bent wire. A typical tinning bath which has proved satisfactory in service is shown in Fig. 1. It holds 15 cwt. of tin and is oil fired. Ancillary plant includes two lead-lined tanks for "raw" and "killed" spirits; a box or tray filled with sawdust for drying off and a tank containing about 40 galls. of crude oil, placed quite near to the tinning bath. The castings must be shot-blasted before tinning. After inspection for surface defects, they are warmed up in the tinbath. After reaching the temperature of the bath they are transferred by tongs or wire to the dilute acid tank and quickly returned to the tinning bath. This transfer is repeated several times until an adequate coating has been imposed. When this has been done, the casting is rapidly dropped into the crude oil tank. A final cleansing in the sawdust bath finishes the process. If the shot blasting is efficient, there is no need to pickle.

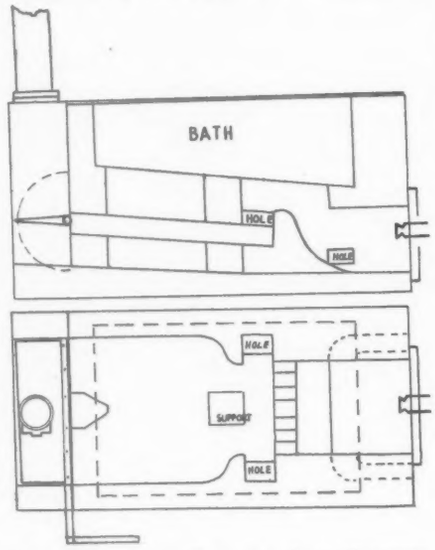

FIG. 1.—TINNING BATH FOR IRON CASTINGS.

Waste Metal Recovery

Under normal circumstances many non-ferrous foundrymen, especially those manufacturing alloys for bearings, are content to dispose of their dross, spillings, sweepings and swarf to firms specialising in the recovery of secondary metals. The prices obtained do not represent the full value of the metal, as the refiners have to cover themselves for processing, capital outlay, depreciation of plant and profit.

The enhanced production called for under war conditions favours the installation of plant for metal recovery, as was fairly common during the last war, and to a marked extent since that time. A plant for this purpose is manufactured by the Wilfley Mining Machinery Company, Limited, of Salisbury House, London Wall, London, E.C.

THE BRYAN DONKIN COMPANY, LIMITED, state that, owing to the present situation, their staff will not be always in attendance at their London office, 3, Victoria Street, S.W.1, and customers are asked to communicate as much as possible with their head office and works at Chesterfield.

Random Shots

Like other victims of the present topsy-turvydom in Europe, "Marksman" has been busy straining his intellect and cricking his back in a painstaking attempt to encompass a hundred per cent. black-out of his premises. Whether or not success has crowned his efforts, let others say (as a matter of fact the local A.R.P. has already given tongue on the subject), but the house has been blackened out and perhaps the reputation of its owner.

* * *

Brown paper and tacks; black paper and drawing pins. Pins and needles from crouching in positions of acute discomfort and even anguish in order that the black-out shall be accomplished and the enemy baffled, bamboozled and generally led up the garden. All these things have been cheerfully and even gladly suffered in a good cause, for, mark you, a tintack has a pointed way of making its presence felt which must make even the most patient people exclaim, but when, after labours and fatigues extending into the small hours, a voice cries out in obvious discontent with what has been done, then indeed the cup is full to overflowing.

* * *

'Twas not as if the walls had not been compassed about with care and a vigilant eye for the straying beam that might give notice of a human habitation. No, "Marksman" has zealously followed instructions and surveyed the doors and windows with a searching and expectant eye, for truth to tell there were doubts about the efficacy of certain gadgets which, though homely, ought certainly to have been effective. The fact of the matter is that curtains are not to be trusted, for whether on rings or runners, they can never be relied upon to return always to the same position. In a word, they wrinkle.

* * *

"Look at your houses from the outside," say the authorities, and obviously such advice is excellent, but should it become necessary to climb the poplar tree in the house next door but one in order to get a glimpse of some particular window, then the matter is not so simple. Again, the bathroom overlooks the garage, and nocturnal expeditions on its roof to try out the efficacy of the plywood shutters are fraught with danger. Yes, sir, your guess is quite correct, the wood *did* warp, for steam is steam whether we be at war or at peace.

* * *

But there was worse than that, for in the early stages of the black-out "Marksman," after a heavy day's work, was blissfully reclining in a steaming hot bath when upon his soap-laden ears came the stunning sound of the front door bell ringing at high pressure. Well, now it takes an air-raid warden, jealous in his regard for the public safety, to fetch a citizen out of a hot bath at midnight, but this one certainly did it, for, as far as he was concerned, the night was young and a front porch a snug enough place. Complete with towel and torch, "Marksman" pursued a watery course to the scene of the conflict, but it took nearly ten minutes to convince the fellow that he had knocked up the wrong house!

"MARKSMAN."

THE NOMINAL CAPITAL of the Northern Aluminium Company, Limited, has been increased by £400,000 in £1 ordinary shares to £1,500,000.

High-Speed Twin-Drive Grinding Machine

In recent years the employment of high-speed grinding machines for removing surplus metal from grey and malleable iron, steel and non-ferrous castings, and from forgings and stampings, has been greatly extended. By using special Bakelite-bonded grinding wheels, run at speeds up to 9,500 surface ft. per min., the production is greatly increased when compared with the output from machines using the normal slow-speed grinding wheels, besides being less fatiguing to the operator.

Extra wheel wear per unit of work done results when a grinding wheel is run at a speed below that for which the wheel was definitely manufactured, and this is particularly true of the synthetic-resin-bonded wheel. When the speed reduction is great the wheel wear is excessive; it will be obvious, therefore, that if the maximum efficiency is to be obtained the peripheral speed of the grinding wheel must be maintained as near as possible to the recommended speed.

Most floor-type high-speed grinding machines are equipped with a three-speed drive to the wheel spindle so that as the wheels wear the speed of the spindle can be increased. For this drive to be effective the two wheels must wear at a uniform rate. In practice it is found that the wheels do not always wear at the same rate on account of their unequal width or of the difference in the strength and skill of the operators, and the difference in the batches of components being ground, some of which are more severe on the wheels than others. When the wheels differ in diameter it is impossible to run the smaller wheel at its correct speed without over-speeding the larger wheel and running the risk of the wheel bursting.

F. E. Rowland & Company, Limited, Climax Works, Reddish, Stockport, who for many years have pioneered developments of the high-speed floor-type grinding machine, have recently developed an entirely new range of machines for which a Provisional Patent has been granted.

The basic idea of the design has been to produce a machine built throughout in accordance with modern machine-tool practice with a view to obtaining the maximum production at the lowest cost, whilst eliminating, as far as possible, all undue waste time involved in operation and maintenance.

Wheels Independently Driven

The most interesting features which have been incorporated are completely independent drive and control to each wheel, which permits unequal wheel wear without loss of efficiency and also reduces time lost in changing speeds and replacing the wheels since these operations affect only one operator at a time. A patented compulsory speed-change device is provided to ensure absence of loss in peripheral speed. The well-known collet type of mounting is employed for the wheels instead of washer plates, thus reducing the time lost in wheel replacement by 75 per cent.

A unique ball and roller bearing application is employed which provides smoother running and longer bearing life. The driving motors are of the standardised type, and no special features are involved. They are totally enclosed on account of the metallic dust present in order to ensure reliability.

The machine is built in three sizes for wheels of 30 in. by 4 in., 24 in. by 3 in., and 18 in. by 2½ in., in which three independent changes of speed are available to each wheel through the use of separate motor drives. The twin-motor arrangement allows each wheel to be run at the most economical speed throughout its life, and the loss of efficiency due to unequal wear in the wheels, which occurs for the reason stated, is thus avoided. There is no wastage of power when it is found necessary to run one wheel only. Figs. 1 and 2 show front and rear views of the 24-in. wheel machine, the cover plate having been removed in the rear view.

The body casting is of rigid construction, covering a large floor area so as to eliminate vibration, and it is shaped for convenience in operation. Each wheel is driven by its own spindle, which is of 40 to 45-ton tensile steel, and ground all over. The spindle takes driving torque only, and no journal load. The high-speed grinding wheels are mounted on collets, as is the practice in precision grinding machines. These collets have not to be disturbed for wheel replacement, which is accomplished by the removal only of the outer washer plate, and wear of the spindle end is thus avoided.

The collets run on ball and roller bearings mounted on a large-diameter fixed sleeve, forming a dead spindle. The journal load is thus taken direct, and the wheel is not overhung. The design permits large bearings being used, which, together with their location, ensures very smooth running and considerably increased life and reliability. The races are positively located and no self-aligning bearings are used. Dust and grit are effectively kept out of the bearings by efficient grease seals.

Three-Speed Drives

Coned pulleys provide the three independent speeds for each grinding wheel, as shown in the close-up view (Fig. 3), and the change-over can be made in the minimum of time. The speed-changing device is independent for each wheel, safe and foolproof. It is controlled by the diameter of the wheel, and is not dependent on the intelligence of the operator, thereby ensuring the maximum factor of safety. The driving belts run in a belt fork which is connected by linkage and gears to the safety lever in the guard in such a manner that if the belts are on the highest speed a new wheel cannot be fitted. Again, the speed cannot be increased unless the wheel has worn down to the correct diameter, so enabling the safety lever to move to the next position without contacting the wheel.

(*Concluded on page* 208.)

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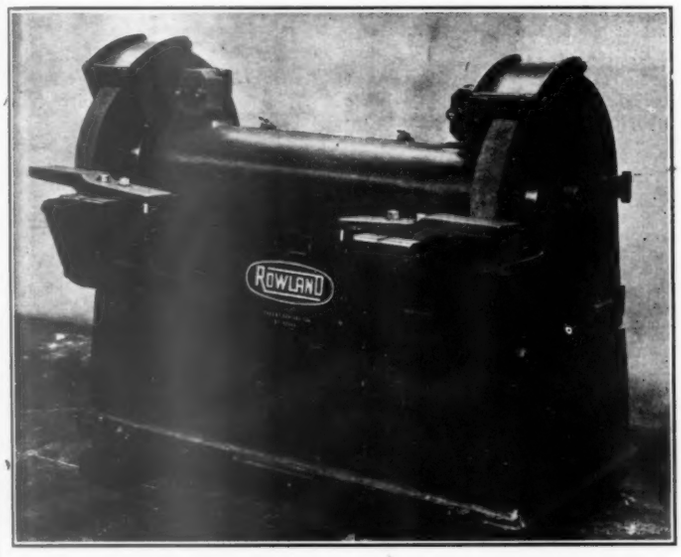


FIG. 1.—FRONT VIEW OF HIGH-SPEED TWIN-DRIVE GRINDING MACHINE.

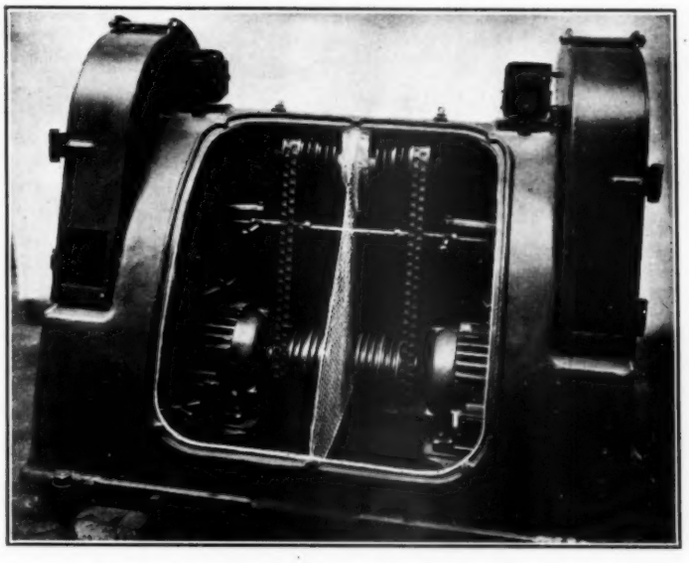


FIG. 2.—REAR VIEW OF THE MACHINE SHOWN IN FIG. 1.

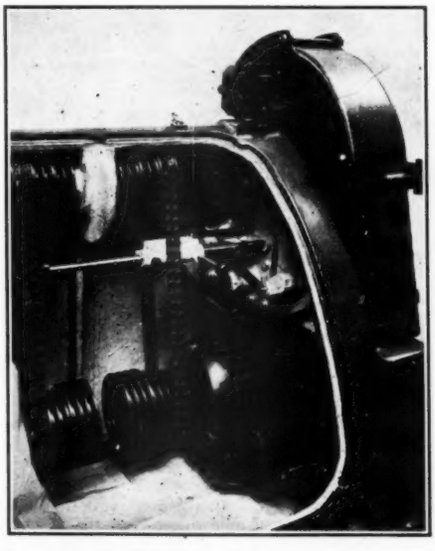


FIG. 3.—CLOSE-UP VIEW OF THE DRIVING MECHANISM.

Metals and Alloys used in Making Rubber Tyres

MR. EDWIN F. CONE has been accorded the privilege by the Goodyear Tyre & Rubber Company, Akron, Ohio, of studying the rôle which certain metals and alloys play, and the extent to which they are essential, in the manufacture of rubber tyres. The article on the subject which he subsequently contributed to "Metals and Alloys" contains data that is of interest to the foundry industry. These particulars are given in the following extracts.

The metal moulds which are the basis of the whole operation of forming and curing the tyres are either bimetallic or not. The Goodyear company claims it is the first one making tyres which use a bimetallic mould. By this is meant that inside the outer rim of the main part of the mould a different metal or alloy is used to form or mould the tread. In the single-metal mould the patterns, which form the impressions in the rubber for the tread, are engraved or cut in the main metal or steel casting—similar to the preparation of a die of die steel for drop or pressed forgings. It is understood that this is the practice of most of the tyre-producing companies except Goodyear.

But first, the mould itself, made in two parts, top and bottom, is of cast steel. They vary in size and weight according to the tyre to be made. They are substantially heavy and resemble a flanged bowl some 2 to 4 in. thick.

A High-Sulphur Steel Casting

The steel casting used by Goodyear is made by a steel foundry in Akron, the Atlantic Foundry Company, and is an electric-furnace product. It is not an alloy steel but it has one unusual characteristic—it is high in sulphur by specification—0.09 to 0.12 per cent. Since phosphorus has recently become essentially an alloying element in the low-alloy, high-strength steels, possibly in this steel sulphur might be regarded as an alloying constituent. The composition of the cast steel is as follows:—C, 0.22 to 0.28; Si, 0.45 to 0.50; Mn, 0.75 to 0.85; S, 0.09 to 0.12, and P, 0.03 to 0.05 per cent.

After normalising, the tensile strength averages 31 tons per sq. in. with a yield point of 22 tons and an elongation of 15 to 20 per cent. in 2 in. The castings are used as normalised.

The sulphur is specified abnormally high because it has been found that, in machining the mould, a much smoother and brighter surface can be obtained, particularly in that portion which forms the side walls of the tyres. In some cases this surface is smooth and for some tyres it is fluted. The sulphur also improves the machinability. Each mould section is machined on the inside to the most exacting accuracy. In a large machine shop many types of machine tools are called upon to perform difficult and exacting machining operations.

Aluminium Die-Casting Segments

The next step is to prepare that portion of the mould which forms the tread, often complicated in design. In these bimetallic moulds the metal which carries the pattern for the tread is a die-cast aluminium alloy. These are made in segments of a circle so that in one complete circle there are from 40 to 60 of these in each half-mould, depending on the size of the mould. These aluminium alloy pieces or segments are from $\frac{3}{8}$ to $\frac{1}{2}$ in. thick. Cast to carefully dimensioned sizes they are machined and fitted into the machined portion of the steel casting so as to form a rigid ring of patterned metal.

The metal selected for this die-cast segment is an aluminium alloy, known as No. 13 alloy, of the following composition:—Si, 12.00; Fe, 0.40; Cu, 0.30, and aluminium, remainder. It is melted in gas-fired crucible furnaces and cast in die-casting machines in the Goodyear plant. There are now two such machines with another to be installed. The castings are not heat-treated for use. The ultimate tensile strength of this alloy is about 14.7 tons per sq. in. with an elongation in 2 in. of 1.3 per cent.

It is evident that when the top and bottom parts of a steel mould, lined on the outer inside edge, are fastened together, a perfect ring of these die-castings is formed below which is the carefully-machined steel casting which forms the side walls. In other words, there is formed a hollow receptacle which, when the plastic rubber mixture is pressed against it, forms the final contour of the tyre—the tread and side walls.

This aluminium alloy was selected because of its die-casting properties, and its freedom from distortion or growth during the uses to which it is put and its permanence. An alloy for use under the exacting conditions must maintain its form, its properties and its original characteristics.

As a rule the aluminium alloy segments have a life longer than necessary because a change in mould design or an alteration in the style of the tread is a frequent occurrence. The used metal is remelted, brought after analysis to its original composition and cast in pigs for re-use.

A Solid Ring of Aluminium Alloy

There is one other type of ring which the Goodyear company employs to form the tread—it is used largely for the large tyres and those other than passenger, the type just described being largely for the latter. In the other type the ring is one complete casting made in a sand mould. It is called the Harsch aluminium tread ring as cast by the John Harsch Company, Cleveland. The alloy used is a lower silicon aluminium alloy, No. 43, of the following analysis:—Cu, 0.10; Si, 4.5 to 6.0; Z, 0.03; Fe, 0.80; Mg, 0.03; Mn, 0.03; other elements, 0.03 per cent.; aluminium, remainder.

This alloy is not heat-treated and in the as-cast condition has a minimum tensile strength of 7.1 tons per sq. in. and a minimum elongation in 2 in. of 3.0 per cent. This alloy is made to U.S. Navy specifications, No. 46-A-1-D Class 2. It is understood, of course, that the pattern for the tread is cast on the inside of this ring. In this case, the used castings are returned to the foundry as scrap for re-melting.

Air bags—the parts that resemble an inner tube, but of heavier sections—are of heavy rubber and are made in cast steel moulds. Steel castings also enter into the construction of the pot heaters, part of the vulcanising apparatus, into which the moulds are placed.

A Cast-Iron Mould

Another type of mould is the steam-jacket mould of cast iron. In these are made and vulcanised certain of the larger and possibly cruder or less highly finished tyres for tractors, buses and similar equipment. For certain types of tyres of this class a cast-iron mould is used in place of one of cast steel. The composition of the two types of moulds is as follows:

	Jacket Moulds.	Tyre Moulds.
Si	2.10 to 2.30	1.80 to 2.00
Mn	0.60 to 0.70	0.60 to 0.70
S	0.08 to 0.10	0.08 to 0.10
P	0.20 to 0.30	0.20 to 0.30

For inner tube and life guard moulds a grade of iron similar to steel mix iron and known as "Sunshine Metal" is used.

Centrifugally-Cast Gear Blanks

ADVANTAGES OVER FORGING

The Ford Motor Company's experimental work in the U.S.A. in casting gear blanks in centrifugal dies, first announced just a year ago, is said to be wholly successful, and centrifugally-cast gears now are in regular production.

Mr. R. H. McCarroll, the Ford metallurgist under whose supervision the development was conducted, has said, according to "The Iron Age," that production of all Ford truck ring gear blanks is now by the centrifugal method. It will be extended to full production of the car ring gear and the transmission cluster gear as quickly as the necessary equipment is completed.

Greater strength, lighter weight, and faster production are the principal advantages of the gears claimed for the new method, Mr. McCarroll said. By using sand cores in the die, undercuts can be made which would be impossible in a conventional forging, he pointed out, and this saves weight and metal.

Still more important, however, is the greater strength of these gears made by centrifugal casting. Etched sections show the reason. In some forgings lines of metal flow are parallel to lines of greatest stress. Because of absence of all flow lines in the centrifugal castings, this condition does not exist. The metal is equally strong in all directions.

Locking the Dies

The simplicity of the centrifugal method is especially noteworthy. The dies, which are made of a special low-carbon steel, are mounted on a turntable designed and built by Ford engineers. There are 18 of them on the turntable. Each begins to spin as it approaches the pouring ladle, continues to whirl for the two minutes required for the metal to solidify, and then stops turning in time for the operator to remove the hot blank and prepare the die for the next casting.

An ingenious feature of the casting turntable is that centrifugal force is used to lock the dies in position. This is done by "dogs" which are pivoted in the middle. There is a weight on one end, and a hook on the other. When the die spins, the weight flies out and drives the hook on to a ledge on the top half of the die, securely locking it into place. When the die ceases to spin, the weight falls down, automatically releasing the die for the removal of the gear blank.

As now set up one man loads the cores into the dies and sets in position the top half of the die, another pours the molten steel, and a third removes the die top and gear blank. Approximately 4 mins. is the time for one complete revolution of the turntable. The dies are spun at 190 r.p.m. in the case of the truck ring gear. For the smaller car ring gear blank, the speed is 325 r.p.m., and for the transmission cluster gear with its still smaller perimeter, the speed is 400 r.p.m.

A.R.P. for Cupola Furnaces

Every iron and steel foundry in the United Kingdom and North of Ireland should immediately write to the Secretary of the British Cast Iron Research Association, St. Paul's Square, Birmingham, for a copy of Special Publication No. 4, unless they are already in possession of it. In it are explicit instructions as to what to do with cupolas before and during air raids, so as to preclude the emission of glare. The pamphlet costs two shillings, post free. To members of the Institute of British Foundrymen the reduced price of one shilling is accorded.

Notes on Steel Foundry Practice

By S. LEETCH

(*Continued from page* 183.)

Typical Green Sand Castings

The casting shown in Fig. 13 forms part of an excavator bucket, which, as is well known, works up and down a long boom, by means of a pinion and rack, scooping up the load from the quarry face, and transferring to a given point. Thus lightness is of paramount importance. The main point of interest is that this was a fabricated job in the first instance, but the working conditions were too severe, and in this case the design was altered for casting purposes, without increasing the weight. It was not until green sand was resorted to that success was achieved, owing to "pulling," but now it is being produced quite satisfactorily, although, of course, its light weight compared with its overall dimensions makes it a highly-priced job.

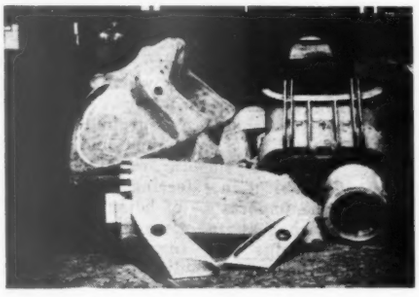


Fig. 13.—Excavator Bucket Casting.

The Sand

Whilst green sand practice has been in common use in steel foundries for many years, it is only in recent times that its use has been extended for larger work. In the past, using various types of natural clay-bonded sands as the bonding medium for synthetic green-sand mixtures, the results obtained were not uniformly good, even when fairly close control was given to the mixing operations. This led, in many cases, to turning the job over to dry sand practice as soon as scabbing, etc., occurred, and in due course only small castings on which little or no machining was required were made with green sand.

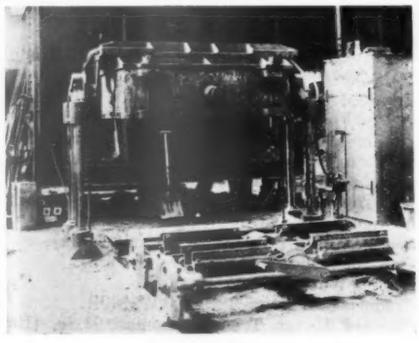


Fig. 16.—Rolling-over Arrangements for Machine Making Yoke Casting.

The introduction of bentonite, an American clay which is more plastic than previously used clays, develops more green strength and much more dry strength; its fine particle size and its ability to retain its power of regeneration after drying at higher temperatures encouraged steel-founders to take up the question of green sand moulding with renewed interest. The result of considerable research work of a high order, in which Mr. T. R. Walker has played a prominent part, is shown by the fact that green sand moulding now plays a big part in steel foundry production, and whilst its many advantages such as reduced drying costs, increased available floor space, lessening of contraction draws or pulls, are impressive, there is no doubt that it calls for very close control in mixing, milling, moisture content, ramming and pouring, if the results are to be consistently good. The standard green sand mix used by the author is as follows:—

Yorkshire sand (natural clay bonded), 25 parts;
Dried Chelford silica sand, 75 parts;
Bentonite, 3 parts;
Moisture content, 3 per cent. checked by Speedy moisture tester.

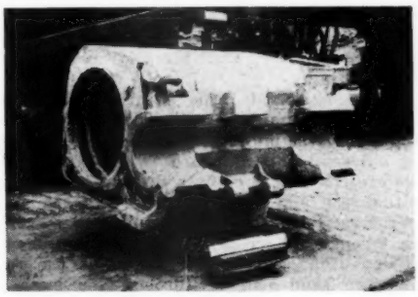


Fig. 14.—Railway Traction Motor Yoke.

The mixture is milled for four minutes in a heavy roller mill, and is used as a facing sand only. The backing sand is obtained from the knocking-out heap, passed through a Royer machine which generally reconditions it. It is known that other foundries reclaim a large portion of the backing sand for green sand purposes with good results, but this means the whole of the sand in the moulding box has to have the same treatment. As will be seen later, the author's foundry reclaims the above Bentonite mix for dry sand practice, and whilst at the present he has an open mind on the subject, it should be emphasised that in both green and dry sand castings the results obtained are very satisfactory.

The following factors must be controlled: (1) The ramming, especially when using pneumatic rammers; (2) soft spots; (3) the permeability, especially of the backing sand; (4) venting; (5) the gating system; (6) the nails; (7) more lifters are necessary; and (8) the moulds must be cast up soon after closing.

Dry Sand and Moulding Machine Practice

The next series of illustrations combines dry-sand practice and machine-moulding practice. At present there are 15 compressed-air machines of various sizes, seven hydraulic squeeze machines, and a number of small hand-operated machines. It is proposed to discuss a job made on one of the latest types of jar-ram roll-over stripping machines. Fig. 14 shows a railway traction motor yoke, the foot rule in the foreground indicating roughly the overall dimensions. The present order is for 800, and great accuracy is demanded both in regard to shape, wall thickness, soundness, etc. The casting forms the main casing of an intricate electrical unit, and when machined must permit of many other parts, such as end-housings, axle-caps, bearings, poles, brush-gear, etc., being assembled in their respective positions. The wall thicknesses are very important, the usual limits being plus 0.15 in. minus 0, as greater variation seriously affects the performance of the motor; fortunately this fault can be discovered on

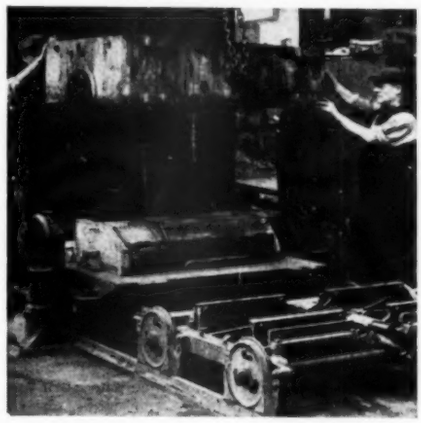


Fig. 15.—Half-Pattern and Pattern-Plate Mounted on Machine for making Casting shown in Fig. 14.

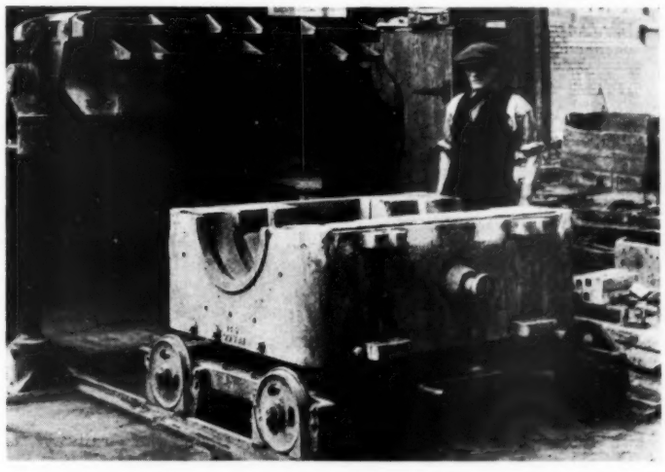


Fig. 17.—Mould ready for Removal to the Casting Bed.

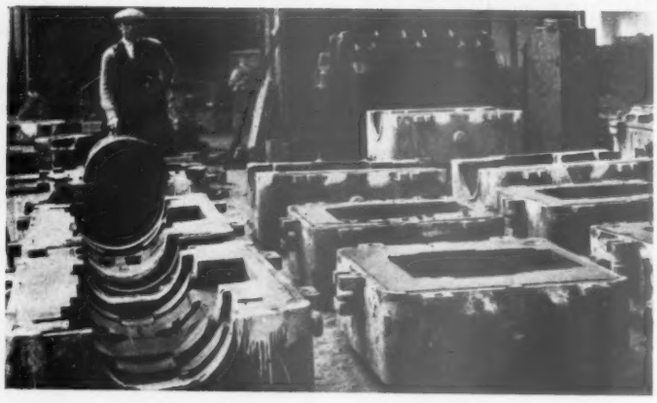


FIG. 18.—GENERAL VIEW OF THE CLOSING BED FOR YOKE CASTINGS.

the test bed. The total weight is also a very important factor, and therefore the designer lightens wherever possible. This unevenness in design is readily seen, as for instance in the the axle bearings which are on one side only. Internally there are four main pole-seatings with a cross section of 8 in. by 2 in., whilst at the commutator end of the casting the wall thickness is reduced to § in. This involves that the pattern cannot be constructed to the usual 1 in 60 contraction allowance throughout. By using this standard allowance the resultant casting would be too long, too wide on the horizontal centre line, and too narrow on the vertical centre line. These facts have been proved by long experience, and it is here where experience can be of value in the pattern shop. Fig. 15 shows the half pattern, pattern plate and machine, with the moulding box being lowered into "bumping" position, and Fig. 16 the rolling-over arrangement. The mould and carriage are shown removed from beneath the pattern in Fig. 17. The pattern is then rolled over and lowered for the next box. Fig. 18 is a general view of the closing bed, with the machine in the background, while Fig. 19 shows two castings after knocking out and blasting with heads and runners complete.

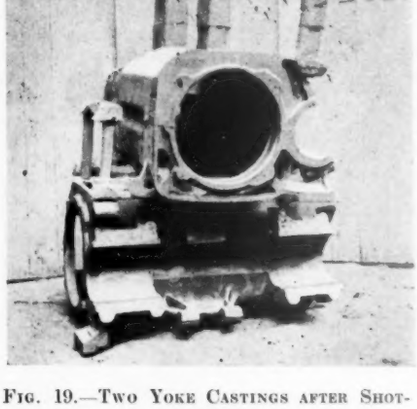


FIG. 19.—TWO YOKE CASTINGS AFTER SHOT-BLASTING.

Sand

Whilst the cores are made from oil sand, carrying a mix similar to that previously referred to, painted with a silica paint whilst hot, then put back in the stove to dry, the facing sand for the mould is made with a high percentage of old sand, the following being a typical mix for dry sand work, and used on the yoke just discussed: 32 parts old sand (from green sand bays); 12 parts Yorkshire bonded-sand; 12 parts Chelford silica sand; and 6 to 7 per cent. moisture, with the addition of 1 per cent. bentonite.

An August plant deals efficiently with new sand and oil sand mixes; it has been specially designed for the milling of reclaimed sand mixes. The old sand is fed into a rotary screen, the fines are taken care of by a de-silting unit, and at the rear end of the screen is a magnetic separator. Both the rough sand, too large to pass through the screen, and any foreign matter are deposited clear of the screen at the rear end. The sand passing through the mesh of the screen falls on to a belt conveyor, thence by means of a vertical bucket conveyor into the storage hopper, which has a capacity of 20 tons. A shute from the hopper leads direct into the loading bucket, the output being controlled by a sliding shutter, worked by a lever. The new sand is stored,

FIG. 20.—AUGUST SAND PLANT AND THE METHOD OF TRANSPORTING SAND.

straight from the railway truck, within shovelling distance of the bucket loader. The bucket is clearly marked with levels for the old sand, Yorkshire sand and Chelford sand respectively, thereby ensuring correct proportions. The bucket is elevated and tipped by electrically controlled gear, very similar to that for charging cupolas, and the sand is deposited into a No. 2 Simpson mill. A water spray, operated by valve and meter on the ground level, gives the requisite moisture content, that of the two new sands having been previously determined by the use of a "Speedy" moisture tester. The sand is milled for 4 min., an "hour" glass being used for the timing. The mill is self-emptying through the bottom, down a shute, and by means of a bucket elevator into the storage tank.

Transport

Fig. 20 shows the ready way of transporting the milled sand to the bays. The existing overhead Herbert Morris run-way and bucket conveyor also serves this plant. The plant is worked by two men, one feeding the rotary screen and the other controlling the bucket loader and mill. The four minutes' milling time is ample to ensure the continuous running of the plant, which was designed to permit of another mixer being installed. In fact, so satisfactorily has the plant functioned that a second mixer has been ordered, and when this is installed the total output will be approximately 10 cwts. every 5 min.

When what is termed the new foundry was opened in 1913, there was installed a central milling plant for all types of mixes, and its product was carried to the various points in the shop by means of a Herbert Morris overhead run-way and bucket conveyor, which is still in daily use and is ideal for the main shop. With extensions and developments taking place which have necessitated ground transport, congestion problems arose, and it was therefore decided to decentralise the milling plant. There are now three distinct plants, all of which are placed alongside rail tracks so that trucks can be unloaded direct to the mill, and ground transport has been reduced to a minimum, and does not interfere with the smooth working of the foundry. The object in referring to this matter is to stress the importance of being prepared to depart from what at one time was ideal practice, and now, due to changed conditions, no longer fulfils the newer conditions.

(To be concluded.)

British Foundry School

DIPLOMA PASS LIST, 1938-39

The following students are awarded the Diploma of the School following the work and examinations for the Session 1938-39. The list is issued in alphabetical order and is not divided into classes. Distinctions may be awarded in each of the four subjects of the examination—foundry metallurgy, foundry technology, foundry management, foundry casting studies and planning (ferrous and non-ferrous).

John Birchall (Horwich).
John Victor Chatterton (Birmingham).
Leonard Clarke (Willenhall).
Victor Dennis Griffiths (Birmingham).
Philip Hector Lawrence, B.Sc. (Bristol), (Derby).
Edmund John Ludlow (London), (Distinction in Foundry Technology and Foundry Casting Studies and Planning—Ferrous).
William Leonard Proctor, B.Sc. (Hons. Manchester), (Birmingham), (Distinction in Foundry Technology, Foundry Management, Metallurgy).
V. S. Ganesh Rao (Jamshedpur, India).
William Roberts (Adlington, Lancs.).
Frank Warren Rose (Leeds).
Frederick Warren Taylor (Walsall).
Bernard Henry Trenear-Thomas, B.Sc. (Eng. London), (Birmingham).
Charles Henry Wilson (Nottingham).

In view of the outbreak of war, the Governing Body, with the approval of the Board of Education, has decided to close the school until further notice. The arrangements for opening the session on September 19 are therefore cancelled, and due notice of future re-opening will be given.

Worshipful Company of Founders' Fellowship

Mr. E. J. Ludlow, whose name appears in the Pass List above, has been awarded the first of the Fellowships recently established by the Worshipful Company of Founders, for the purpose of providing further facilities for training to men of outstanding talent.

The Properties of Grey Cast Iron, with Special Reference to the New B.S. Specifications

A REPORT OF THE CAST-IRON SUB-COMMITTEE OF THE TECHNICAL COMMITTEE OF THE INSTITUTE OF BRITISH FOUNDRYMEN

The rights of publication (in this case specifically granted) and translation of this report (Special Report No. 1), either in part or in full, and the rights of abstracting, are reserved by the Institute of British Foundrymen. All correspondence relating to this Paper should be addressed to the Secretary, St. John Street Chambers, Deansgate, Manchester, 3. The extracts from specifications given in this report are reprinted by permission from British Standard Specifications 321 and 786, official copies of which can be obtained from the British Standards Institution, 28, Victoria Street, London, S.W.1. Price 2s. 2d., post free.

The need for a specification to cover grey cast iron, in which the test-bar size is related to casting thickness, was appreciated many years ago and culminated in the publication of the British Standard Specification 321 in 1928. This specification was drawn up largely on the recommendations of the Institute's Test-Bar Committee, under the chairmanship of Mr. John Shaw. The outstanding feature of this specification was the introduction of round test-bars in three sizes, representing various sectional thicknesses, as given in Table I.

TABLE I.—*Thickness of Castings Represented by Test-Bars in the 1928 Edition of B.S.S. 321.*

Name of bar.	Cast dia. Inches.	Cross-sectional thickness of casting represented.
S bar ..	0·875	Up to $\frac{3}{4}$ in. thick.
M bar ..	1·20	From $\frac{3}{4}$ to 2 in. thick.
L bar ..	2·20	Over 2 in. thick.

This specification has served a very useful purpose and the principle of varying-sized test-bars has been adopted in other countries, notably the U.S.A.[1] M. Léonard has recently prepared a report for the International Committee on Testing Cast Iron[2], which shows that varying-sized test-bars have been adopted by almost all countries, particularly for tensile testing.

Several years' working of this specification have brought out a few anomalies which have been rectified in the revision recently carried out by the B.S.I. The revision is mainly concerned with bar sizes.

The work of Swift and others[3 4 5] showed that the thicknesses of castings represented by the various bars were too great, although the various workers did not agree on the actual ideal figures. The revision, therefore, was based on the assumption that the diameter of the test-bar should not represent a casting of larger thickness than the bar diameter. This is shown in Table II. It was also agreed that the "S" bar of $\frac{7}{8}$ in. dia. was too heavy for that section of the trade dealing with very light castings, and the 0.6-in. dia. bar was introduced to represent castings of $\frac{3}{8}$ in. section and less.

TABLE II.—*Bar Sizes and Thickness of Castings Represented in 1938 Edition of B.S.S. 321.*

Name of bar.	Cast dia. Inches.	Cross-sectional thickness of casting represented.
0·6	0·6	Not exceeding $\frac{3}{8}$ in.
0·875	0·875	Over $\frac{3}{8}$ and not exceeding $\frac{3}{4}$ in.
1·2	1·2	Over $\frac{3}{4}$ and not exceeding $1\frac{1}{8}$ in.
1·6	1·6	Over $1\frac{1}{8}$ and not exceeding $1\frac{5}{8}$ in.
2·1	2·1	Over $1\frac{5}{8}$ in.

Much trouble had been experienced with the "L" bar owing to the high loads required to break it, and two alterations were made to meet these difficulties. The first was that the bar diameter was reduced from 2.2 in. dia. to 2.1 in. dia. with the transverse span increased from 18 to 24 in., with the result that the minimum breaking load for Grade A was reduced from 10,000 to 6,660 lbs. At the same time the turned diameter for the tensile test was reduced from $2\frac{1}{2}$ sq. in. area to 2 sq. in. area, reducing the breaking load for Grade A from 25 tons to 20 tons. This also enabled the bar to be threaded 2 in. dia. without risk of breaking in the roots of the threads.

A further alteration was the introduction of an intermediate bar between the "M" and the "L," which was made additionally necessary by the fact that the "M" bar now only represented castings with sections from $\frac{3}{4}$ in. to $1\frac{1}{8}$ in., so that it was desirable to avoid the use of the "L" bar for castings just over this section, on account of the size and loads necessary to break this bar, even in its modified form. This bar was fixed at 1.6 in. dia., based largely on the recommendation of Harbach to the Institute of British Foundrymen's Conference in 1935.[6] Thus the revised B.S. Specification No. 321 now has five bar sizes as given in Table II. It will be noticed that the designations of "S," "M" and "L" are superseded by the use of the bar diameter.

The other modifications to Specification No. 321 are:—

(1) Certain alterations in deflection requirements which are discussed later.

(2) The term "Modulus of Rupture" is altered to "Transverse Rupture Stress." The use of this method as a convenient way of expressing transverse strength in tons per sq. in. without the necessity of giving full details of bar size and span is recommended by this Sub-Committee.

(3) The graph showing the corrected minimum breaking load for bars the diameter of which varies from standard is now omitted and replaced by a table of correction factors. This table also gives factors from which the transverse rupture stress can be calculated directly from the breaking load for all sizes of bar, within the permitted variations in diameter. The use of these correction factors is imperative if accurate results are to be obtained, and the measurement of bar size at fracture should always be carried out.

(4) Permission is granted to machine transverse test-bars if desired.

(5) Provision is made for screwed ends as well as plain ends for tensile test-bars. This is particularly advantageous, as the specification now states that "the use of self-aligning grips is recommended." This Sub-Committee strongly endorses this recommendation.

High-Duty Cast-Iron Specification

Owing to the rapid improvements in grey iron over recent years, the British Standards Institution decided to issue a further specification for cast iron of strength in excess of Grade A in B.S.S. 321. This is now issued as B.S.S. No. 786, and covers three grades of high-duty cast iron. This specification contains a foreword drawing attention to the desirability of not specifying a higher grade of cast iron than required, in view of expense and founding difficulties.

B.S. Specification No. 321 is taken as the basis of the high-duty cast-iron specification in nearly all parts except the actual test requirements, the main difference being that the 0.6 bar is omitted, the 0.875-in. dia. bar being taken as representing all castings below $\frac{3}{4}$ in. The reason for this was that there were insufficient data on this small bar when used for high-duty cast iron, as it appeared that most users had found that the 0.875 bar satisfactorily represented all commercial castings below $\frac{3}{4}$ in. thickness. Tensile strength was taken as the basis for the three grades, the requirements for the 0.875 bar being fixed at 15, 18 and 22 tons per sq. in. for grades 1, 2 and 3 respectively. These figures were arrived at as being representative of:—

GRADE 1.—High-quality engineering iron made by ordinary processes usually with the use of small quantities of steel scrap or refined iron.

GRADE 2.—The highest grade of engineering iron made by ordinary processes such as high steel or refined iron mixtures or ordinary nickel or other alloy iron.

GRADE 3.—Irons made by special process such as inoculation, superheating, etc.

In making recommendations for the tensile requirements for the other sizes of bar and for the transverse requirements of all grades and sizes of bar, the Institute's Cast Iron Sub-Committee collected and considered data from commercial sources on 283 bars. All these bars were commercially produced in Great Britain, and not produced from metal melted specially for the purpose, so that the data obtained represent modern commercial practice.

Based largely on the results submitted by the Institute of British Foundrymen, the tensile requirements of the various bars for each grade were decided upon as shown in Table III (see also Fig. 1, Appendix). In this connection reference should be made to the remarks made later in this report regarding decreasing strength with bar size.

TABLE III.—*Tensile Requirements for High-Duty Cast-Iron Specification 786. (Tons per sq. in.)*

Name of bar.	Grade 1.	Grade 2.	Grade 3.
0·875	15	18	22
1·2	14	17	20
1·6	13	16	19
2·1	12·5	15	18

The question of fixing the relative transverse tests was more difficult, as no definite relationship between transverse and tensile could be established. The appropriate Institute Committee considered the data available in the light of the ratio of transverse rupture stress to tensile strength. It was found that as a general principle, the ratio was rather over 2 to 1 for low-grade irons, and decreased to 1.6 to 1 for the highest results available. These conclusions were only general, and many results differed widely from the average.

The transverse test requirements were fixed by the B.S.I. on information before them, as given in Table IV (expressed as transverse rupture stress, from which the breaking load is calculated). The basis used was a constant addition of 11 tons per sq. in. to the tensile to obtain the transverse rupture stress.

TABLE IV.—*Transverse Rupture Stress Requirements, High-Duty Cast Iron. Specification* 786.

Bar dia. Inches.	Grade 1.	Grade 2.	Grade 3.
0·875	25·9	28·9	33·0
1·2	25·0	28·0	31·0
1·6	24·0	27·0	30·0
2·1	23·6	26·1	29·1

The figures suggested by the Institute were on the whole higher than those adopted by the B.S.I. and given in Table IV, and it is the opinion of the Cast Iron Sub-Committee that the transverse test requirements can more easily be met than the tensile test requirements (see Fig. 2 Appendix). The machining of test bars was shown by Harbach[4] to give higher transverse results, which thus makes the requirements still more easily met.

The deflection requirements were originally fixed on a mathematical basis from the deflections given in B.S.S. 321. This was complicated by the fact that these deflections, originally arrived at empirically, were not mathematically related between the two grades. The Cast Iron Sub-Committee was able to demonstrate from the results on 460 tests that the deflection does not rise proportionately with the transverse strength, and the original figures were modified in the light of the data submitted by this Sub-Committee. These modifications reduced the number of failures in deflection from 10 to 1½ per cent. of the results examined. The final specified figures are shown in Table V. (See also Figs. 3 and 4, Appendix).

TABLE V.—*Transverse Breaking Load and Deflection Requirements for High Duty Cast Iron. Specification* 786.

Bar Dia. In.	Centres. In.	Grade 1.		Grade 2.		Grade 3.	
		Load. lbs.	Defl. Ins.	Load. lbs.	Defl. Ins.	Load. lbs.	Defl. Ins.
0·875	12	1,270	0·11	1,420	0·12	1,620	0·13
1·2 ..	18	2,120	0·16	2,370	0·17	2,630	0·18
1·6 ..	18	4,800	0·13	5,400	0·14	6,000	0·16
2·1 ..	24	8,000	0·17	8,850	0·19	9,850	0·21

The examination from a mathematical point of view of the transverse requirements in Specification 321/28 showed that considerable anomalies existed, and whilst it was felt that it was not desirable to alter existing minimum breaking loads, as these had now become so well established, the deflection requirements were modified, as shown in Table VI. These modifications were related to the actual results submitted by the Institute.

Considerable discussion took place within the Cast Iron Sub-Committee as to the desirability, or otherwise, of specifying lower strengths in the larger bars than the smaller bars. The American specification makes no such allowance, but it was agreed that a larger grain size was to be expected in large bars than in small ones, quite apart from graphite size or matrix structure, which gave a reduced strength. The figures agreed upon were based upon the figures that would be normally expected from the various size bars when using similar classes of material in each grade with due adjustment for variation of thickness. It must be clearly understood that they do not represent the figures that would be expected from different size bars poured from the same ladle of metal; such bars would be expected to show a larger drop in strength than that allowed in the specification. (See also Fig. 1, Appendix.)

TABLE VI.—*Transverse Breaking Load and Deflection Requirements for Grey Iron Castings. Specification* 321, 1938 *Edition.* (*Deflections specified in the* 1928 *Edition are shown in Brackets.*)

Bar Dia. In.	Centres. In.	Grade A.		Grade C.	
		Load. lbs.	Defl. Ins.	Load. lbs.	Defl. Ins.
0·6 ..	9	530	0·07	420	0·06
0·875	12	1,185	0·10 (0·12)	960	0·09 (0·10)
1·2 ..	18	1,950	0·15 (0·15)	1,600	0·13 (0·12)
1·6 ..	18	4,280	0·12	3,650	0·10
2·1 ..	24	6,660	0·15	6,020	0·14

The Cast Iron Sub-Committee has scrutinised the specifications very closely at all stages, and it will be seen that it has related the theoretical considerations with commercial results. It, therefore, feels that the requirements for each grade in the two specifications represent very fairly what may be expected of each grade of material, allowing a reasonable working margin above the minimum requirements.

Mechanical Properties Not Included in B.S. Specifications

Following the long-established practice, the quality of iron castings is judged by and specified on such mechanical properties as tensile strength and transverse strength, whilst recognition is sometimes taken of the elastic properties of the iron, as indicated by the deflection measured in the transverse test.

Although these properties are considered the most suitable from the specification point of view, the engineer and designer has frequent necessity to refer to other properties of cast iron, and some attempt is made in the second part of this Report to indicate the approximate values to be expected for these other mechanical and physical properties, and to indicate where possible how these properties are likely to vary with change of grade as measured by the tensile test.

It must be appreciated that the information which can be given in a general report must be sufficiently flexible to cover the different types of grey cast iron likely to be met to-day. For example, tensile strength is, generally speaking, closely related to the structure of the iron, but, on the other hand, this strength is not necessarily related to the hardness of the iron, nor in turn is it related to such other factors as machinability. It is for this reason that it is impossible to draw up concrete specifications covering a number of the mechanical and physical characteristics of iron castings, more especially since the development of new types of cast iron with different properties makes the whole matter more complex. The American Foundrymen's Association and the American Society for Testing Materials' Symposium on Cast Iron[7] dealt more fully with these properties than it is possible to do in this Report.

Compressive Strength

Next after the tensile and transverse strengths of cast iron, the compressive strength is regarded as the most important, and, in fact, a very large number of applications of cast iron depend on this property more than on those previously mentioned; for example, in machine castings and in structural parts generally, iron castings are found to be used more in a state of compression than either in tension or subject to transverse stress.

The compressive strength of cast iron does not bear direct relationship to the tensile strength, in fact an investigation of a number of test results available has shown that the ratio between compressive strength and tensile strength varies inversely as the latter increases.

For ordinary cast iron, the compressive strength is about four times the tensile, and for Grade 3 high-duty cast iron, it is about three times the tensile, the intermediate values being proportional. Thus, the compressive strength of the various grades of cast iron may be taken to be approximately as given in Table VII.

TABLE VII.—*Approximate Compressive Strength for each Grade of Cast Iron.*

Grade.	Tensile Strength. Tons per sq. in., 0·875 bar.	Compressive Strength. Tons per sq. in.
General C ..	10	40
General A ..	12	46
High Duty 1 ..	15	54
High Duty 2 ..	18	60
High Duty 3 ..	22	66

Elastic Modulus

The modulus of elasticity is a measure of the rigidity of a material under load, and is usually expressed in millions of pounds per sq. in. The work carried out on deflections (referred to in the earlier part of this Report) showed that strong irons are more rigid than weak irons; it follows, therefore, that the elastic modulus rises with increasing strength. In grey cast iron the modulus of elasticity may be measured from the transverse test by two methods:—

(1) By the deflection at 25 per cent. of the ultimate strength at which load the plastic deformation is very small;

(2) By separating the elastic from the plastic deflection at breaking load.[8]

The approximate values for different grades of cast iron are given in Table VIII.

TABLE VIII.—*Approximate Values of Modulus of Elasticity for Each Grade of Cast Iron.*

Grade.	Tensile Strength. Tons per sq. in., 0·875 bar.	Modulus of Elasticity. Millions of lbs. per sq. in.
General C ..	10	10 to 14
General A ..	12	12 to 16
High Duty 1 ..	15	14 to 18
High Duty 2 ..	18	16 to 20
High Duty 3 ..	22	19 to 23

Impact or Shock Resistance

The impact strength of cast iron depends upon a combination of strength, elasticity, and the ability to deform plastically under load. If any of these properties be low in value the impact strength tends to be low. In general the elastic modulus increases with strength and the plastic property is fairly constant at about 20 to 25 per cent. of the total deformation at breaking load. Therefore, impact resistance rises with strength provided that the plastic property does not vary from normal. In the case of some austenitic cast irons the plastic property is very high, thus these irons have good impact strength even when the tensile strength is comparatively low. Conversely, if a high strength iron has poor plastic properties, then the impact strength of such an iron is liable to be low.

As yet there is no standard test for impact strength of cast iron, but considerable attention is being given to the development of such a test, since it is regarded as being the best measure of "toughness" and is therefore of great importance in measuring the quality of iron castings. Results so far obtained with the single blow and repeated blow tests confirm the trends mentioned above, but until some degree of standardisation has been reached the publication of figures is inadvisable.

Fatigue Strength

A certain amount of work has been conducted in recent times on the fatigue strength of cast iron. Work carried out both in the U.S.A. and in Great Britain seems to indicate that for grey cast iron the ratio of fatigue to tensile strength varies from about 0.4 to 0.57. For grey iron this gives a fatigue strength of between 4 and 11 tons per sq. in. For the special high test irons, used for example for crankshafts, the fatigue strength would be pro-

portionately higher. Where stresses are mainly or entirely compressive, the fatigue ratio reaches much higher values.

In considering the question of fatigue strength, it should be mentioned that practical experience has shown that cast iron is much less sensitive to the effects of grooves and notches than is steel.

Hardness

The hardness of cast iron is usually measured by the Brinell test, using a 10 mm. ball with 3,000 kg. load. This test is more suitable for cast iron than the other types of test which use small balls or pyramids for making the indentation, as the results obtained from these latter types are frequently misleading owing to the size of the indentation being comparable with the size of the graphite or other micro constituents.

There is usually no direct relationship between the hardness of castings and the other mechanical properties, due to the fact that hardness is a complex property, depending in cast iron on the graphite size, on the hardness of the matrix, and on the quantity and distribution of hard inclusions, such as phosphide-eutectic or carbides. For general grey iron castings the hardness will vary from 140 to 220 Brinell, and above this upper hardness limit, the castings are usually considered as unmachinable. With modern high duty and alloy cast irons, however, in which the higher hardnesses are achieved by hardening the matrix, the limit of machinability is raised, and consequently such irons are machinable by ordinary methods up to 260 or even 300 Brinell.

Other Mechanical Properties

The investigation of other mechanical properties, such as shear, torsional, and creep strength, has not yet received much attention in Great Britain, and the information available is very meagre. Definite figures for these properties cannot, therefore, be put forward.

Abroad some attempt has been made to popularise the shear test carried out on small test-pieces trepanned from the body of the casting. The test-piece must of necessity be small and, particularly when taken from the body of a large casting, such factors as graphite size and general soundness of the metal have a predominant effect. It is felt in this country, therefore, that the test results are difficult to interpret and the test is not particularly reliable.

Certain work on creep strength has been carried out by the National Physical Laboratory[6] and those interested in this property are referred to this research.

Physical Properties of Cast Iron*

Specific Gravity.—The specific gravity of cast iron varies with the quality of the metal. Thus, a coarse-grained open structured cast iron of relatively poor quality will have a specific gravity in the range 6.8 to 7.2, whilst a high-duty grey cast iron will have a specific gravity of about 7.6.

Specific Heat.—The specific heat of cast iron is about 0.13 in the temperature range from normal to 100 deg. C., and rises to about 0.175 at 1,000 deg. C. The specific heat of the molten metal at 1,300 deg. C. is about 0.22. Insufficient data are available to relate the specific heat to the quality of the metal.

Co-Efficient of Thermal Expansion.—The co-efficient of expansion at room temperature for ordinary grey iron is 9 to 11 $\times$ 10 ^{6} per deg. C.

Thermal Conductivity.—The available data for thermal conductivity of grey cast iron show that the thermal conductivity varies from 0.110 to 0.137 C.G.S. units, the value decreasing with rising temperature. The work of Donaldson[10] should be referred to.

Electrical Properties.—The electrical resistance of ordinary grey cast iron lies between 75 and 100 microhms per cub. cm. The magnetic permeability ranges from 200 to 1,000. With regard to both the electrical and magnetic properties of cast iron a wide range of values is obtained, the properties depending to a marked extent on composition and structure.

General Properties.—Other properties of cast iron, such as wearing quality, resistance to corrosion and heat, machining qualities and so on, all depend on the structure and composition of the iron and on their industrial application.

* The physical properties given above are for grey cast iron and do not apply to austenitic grey cast iron.

[1] American Society for Testing Materials. Specification A 48-32 T and Revisions.

[2] "La Fonderie Belge," No. 52. Jan.-Feb., 1938.

[3] Swift, H. W. Proc. Inst. Brit. Found., Vol. XXIV, page 635

[4] Shaw, John. FOUNDRY TRADE JOURNAL, Nov. 11, 1935, page 387.

[5] Jungbluth, H. Proc. Inst. Brit. Found., Vol. XXIX, page 242.

[6] Harbach, G. L. Proc. Inst. Brit. Found., Vol. XXVIII page 317.

[7] American Foundrymen's Association and American Society for Testing Materials. "Symposium on Cast Iron."

[8] Tapsell, H. J., Becker, M. L., and Conway, C. G. J.I.S.I. 1936, Part I, page 303.

[9] Pearce, J. G. J.I.S.I., 1934, Part I, page 331.

[10] Donaldson, J. W. J.I.S.I., 1933, Part 2, page 225.

APPENDIX

DATA EXAMINED BY THE SUB-COMMITTEE IN CONNECTION WITH THE REVISION AND DRAFTING OF B.S. SPECIFICATIONS.

The following illustrations do not contain all the results examined, but are extracted to illustrate the trends observed.

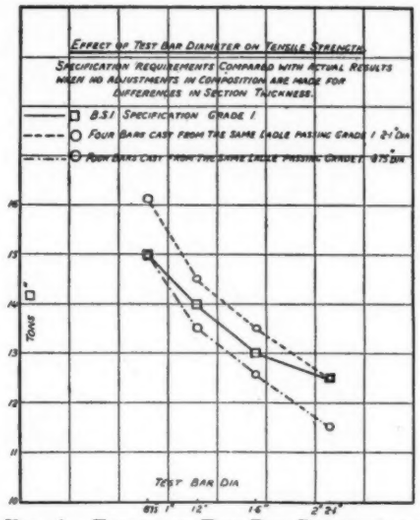

EFFECT OF TEST BAR DIAMETER ON TENSILE STRENGTH.
SPECIFICATION REQUIREMENTS COMPARED WITH ACTUAL RESULTS WHEN NO ADJUSTMENTS IN COMPOSITION ARE MADE FOR DIFFERENCES IN SECTION THICKNESS.
B.S.I SPECIFICATION GRADE 1
FOUR BARS CAST FROM THE SAME LADLE PASSING GRADE 1 2" DIA
FOUR BARS CAST FROM THE SAME LADLE PASSING GRADE 1 .875" DIA
TONS
TEST BAR DIA
.875
1"
1.2"
1.6"
2"
2.4"

FIG. 1.—EFFECT OF TEST-BAR DIAMETER ON TENSILE STRENGTH.

Specification requirements for Grade 1, B.S.S. No. 786 compared with actual results when no adjustments in composition are made for differences in section thickness. The lower dotted line shows that an iron suitable for the 0.875 bar will not meet the requirements of the larger bars, so that adjustment of mixture is necessary. The upper dotted line confirms this effect.

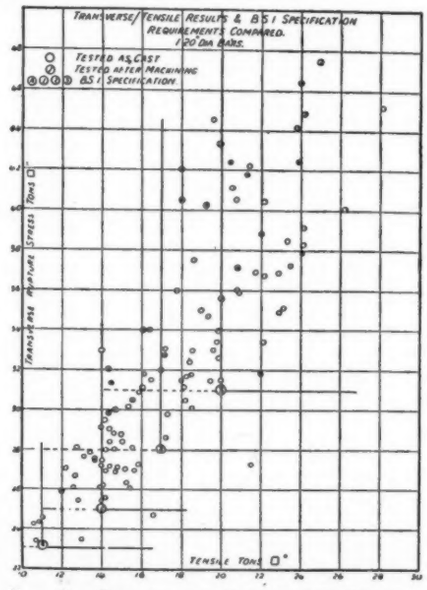


FIG. 2.—TENSILE AND TRANSVERSE RUPTURE STRESS RESULTS COMPARED WITH THE B.S. SPECIFICATION REQUIREMENTS, 1.2-IN. DIA. BARS. (SEE NOTE IN NEXT COLUMN.)

Specification requirements are shown by circles enclosing letters or numbers, and only those results included within the full lines at right angles from these circles pass their particular grade in both tensile and transverse. Results to the left of the upright line and above the dotted horizontal line only pass in transverse in that particular grade. Thus, for 25 results which pass Grade 1 in transverse and are below Grade 2, only 14 of these will pass in tensile.

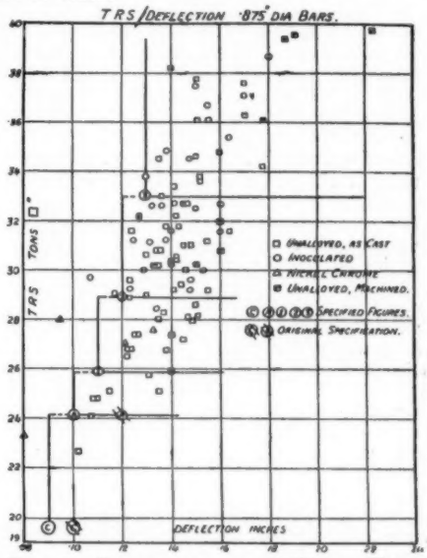


FIG. 3.—DEFLECTIONS ON 0.875-IN. BARS, COMPARED WITH TRANSVERSE RUPTURE STRESS.

Specification requirements are shown by circles enclosing letters or numbers, and only those results included within the full lines at right angles from these circles give satisfactory deflections for their own particular grade in transverse.

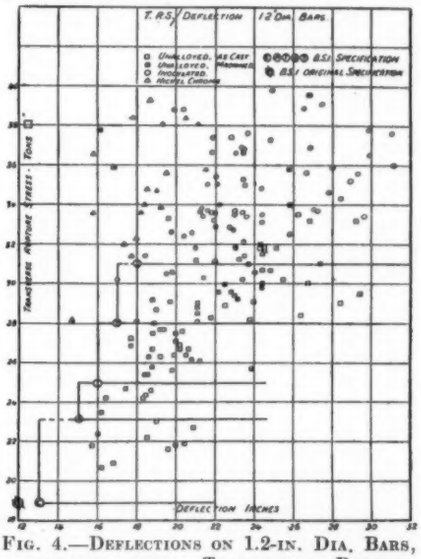


FIG. 4.—DEFLECTIONS ON 1.2-IN. DIA. BARS, COMPARED WITH TRANSVERSE RUPTURE STRESS.

This graph should be interpreted in the same way as Fig. 3.

Foundry Education and Training in Great Britain

By J. G. PEARCE, M.Sc., M.I.Mech.E., M.I.E.E., F.Inst.P.

(*Concluded from page* 185.)

Technical Training for Executive Grades

The growth of foundry science necessitated provision for the technical training of those who exercise executive responsibilities. Furthermore, the growth in size of foundries and of mechanisation makes it desirable that in such establishments there should be several men in various key positions who are adequately qualified technically, and it will be clear that while this training is indicated for executive grades, it is also intended for those whose responsibilities are mainly technical or both technical and executive.

Although universities form a natural reservoir of men with the highest technical qualifications, as indicated above, the number of graduates leaving these departments annually does not encourage the belief that a large accession of university-trained men to the foundry industry can be expected, either now or in the immediate future, although, of course, a small number of graduates do find their way into the industry.

Loughborough College makes provision for foundry teaching, but mainly for its engineering students, as far as day instruction is concerned. A few years ago the University of Sheffield, with the co-operation of the Institute and with the financial assistance of a number of firms in the industry, made provision for instruction in foundry science, and it is understood that candidates for the honours degree in metallurgy, involving three years' study after the intermediate examination, may take either ferrous metallurgy, non-ferrous metallurgy or foundry metallurgy. Since the scheme was begun in 1935, sufficient time has not elapsed to see to what extent the scheme yields recruits to the industry, although there is already little doubt that it has had, from a foundry point of view, a beneficial influence on the training of metallurgists in general. Further reference to the Sheffield scheme will not be made here, as it is understood that fuller treatment is being given in another Paper.

The difficulty of training men through institutions outside the industry is heightened by the difficulty of knowing whether a given candidate so trained will find the industry congenial to him and, as in other fields of activity, the higher branches of foundry work call for qualities of personality, character and experience, not necessarily brought out or developed by a formal scheme of education. The skilled foundry executive can comparatively quickly make up his mind whether a young man has the necessary qualities for success in foundry work, and another proposal for a full-time training scheme put forward by the author in 1934 was based in part on a recognition of the impossibility of teaching practical foundry work in a school and of the fact that the industry itself was in a measure the best possible sieve for determining what men were likely to be successful in it. It was furthermore thought that, to be successful, any school for training foundrymen should be associated with the industry in a way which has not perhaps been fully achieved either in this or in any other sphere, and these considerations led to the establishment of the British Foundry School, of which a brief description can now be given.

The British Foundry School

The School opened for its first session in 1935 and is now in its fourth year. The course lasts for one academic year, from September to July. The School is financed in part by a group of ten institutions, of which the Institute is one, being research associations, trade associations or technical institutions connected with the industry (Appendix I gives a list of the initial group concerned), in part by donations from industrial firms, in part by students' fees, and in part by a grant from the Board of Education. The subscribing institutions and bodies nominate representatives to the Governing Body, to which a number of prominent industrialists have also been co-opted, and the author has the honour of being its Honorary Adviser and Honorary Treasurer.

The School is thus entirely controlled by the industry through its Governing Body, but it is necessary to make amply clear that the fullest co-operation is exercised with the educational authorities, both national and local, and both the Board of Education and the Birmingham Education Committee are represented on the Governing Body. Indeed, it would not be too much to say that without the broad-minded and continuous help of the Board of Education and practical assistance from the local authority, the School could neither have come into existence nor continued to function. Birmingham was chosen as a convenient central city in what is perhaps the most densely populated foundry area in the country, and for convenience the School is housed in the buildings of the Birmingham Central Technical College, by arrangement with the Birmingham Education Committee. The School is national in character and awards a Diploma on the result of its annual examination, which is endorsed by the Board of Education.

It is necessary to emphasise the fact that the whole range of foundry production is covered by the School, grey iron, white and chilled iron, malleable cast iron, cast steel and cast non-ferrous metals, since the principles of founding are common to all and the student is not permitted to specialise. The curriculum is available to those interested.

The number of students can in the nature of the case never be large. Thirty-six students have been enrolled to date, and an annual enrolment of twelve to fifteen students will justify its continuance. Judging by the experience of the French Foundry High School in Paris, to which the British Foundry School has similarities, there should be no difficulty in securing a minimum of twenty students per annum, which would for the time being be regarded as a maximum.

The School aims at attracting young men who have already entered the industry, who have obtained some practical experience in it, and who have some technical knowledge, at least equivalent to that of an ordinary or higher national certificate, and who give evidence that they are suitable for advancement to higher responsibilities. In the large majority of cases these young men are nominated by their employers, who both pay the School fee (£30 for the session) and maintain the student during the period of instruction (£110 to £120 is a reasonable minimum for this period). At the same time, nothing prevents a suitably qualified student from taking the course on his own initiative and in some areas local Education Committees are prepared to aid suitable students who would otherwise find financial difficulty in entering. The average age of the students is about twenty-four, and about one-seventh of the candidates have been to public schools, and a similar proportion have university degrees. The Governing Body preserves a measure of elasticity in assessing entrance requirements, being prepared to balance more or less technical education with less or more practical experience, if they are satisfied that the candidate is of the right calibre. The mixing for a year of a group of young men with varying experience and training is of the highest value to them and, apart from the United Kingdom, students have been sent to the School from New Zealand, South Africa, India and Egypt.

The curriculum is such as to make a very hard year's work, and considerable demands are made on the students' own time, so that they are not permitted to take additional work, although in certain cases part-time classes are specified in the College to equalise variations in experience and training. The basic part of the curriculum consists of lectures by the lecturer-in-charge, Mr. J. Bamford, B.Sc., and the permanent staff, with practical work in metallurgical analysis, microscopic examination, mechanical testing, sand testing, pyrometry and foundry work. No attempt is made to teach practical founding, since practical experience in a foundry is a requirement for admission to the course; neither are students taught to become laboratory workers, but rather to understand and interpret the results of laboratory tests. They do, however, carry out practical work in metal mixing and melting practice, and various aspects of management such as costing and time study are illustrated.

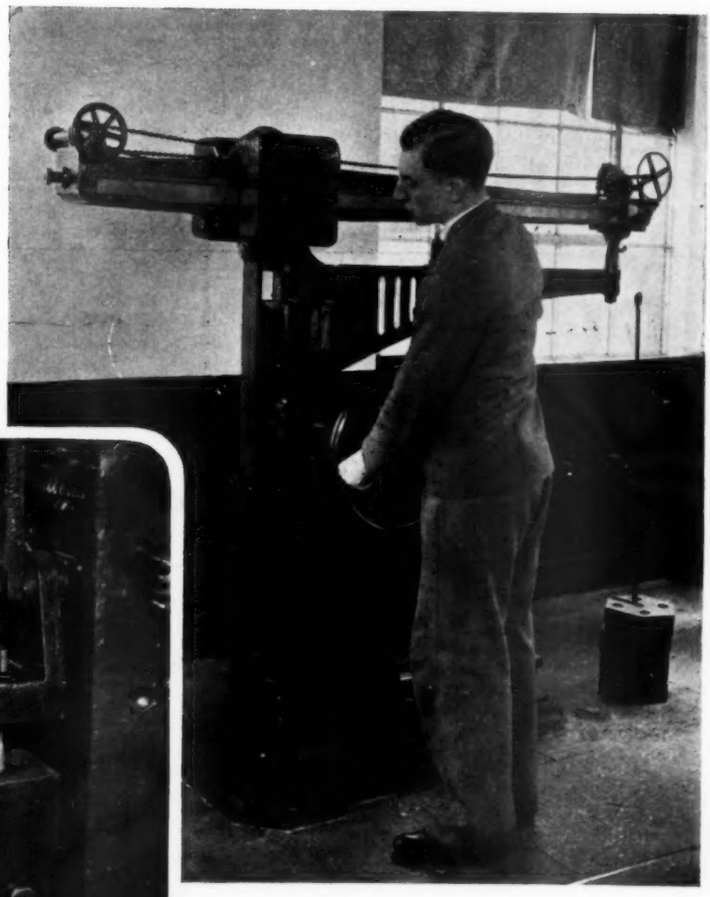
Apart from this basic work, the curriculum has certain special features. The first of these is a series of lectures, 100 to 120 in number, by nationally-known foundry specialists, and not only is an exceptional range of practical knowledge thus placed at the disposal of the students, but contact is provided with the outstanding men in the industry, and each lecture is followed by full discussion. As opportunity offers, lectures are given by outstanding visitors from overseas.

The second special feature of the curriculum is the arrangement each week of a foundry visit, about forty being paid during the School year, including a group of visits once a year to a centre away from the Midlands, and so far Scotland, London and the South and Belgium and France have been visited. The visits are of the highest possible value to students, and the Governing Body is greatly indebted to those foundries, blast furnaces, etc., which permit visits to take place.

The third special feature of the curriculum is the time and attention devoted to what are conveniently termed moulding and casting studies and foundry planning. In the moulding and casting studies, the student is furnished with a blue-print (or a casting or a pattern) and is expected to provide the whole of the data required for the complete foundry production of the job, based on the number of pieces required. He is expected to detail completely the material equipment, tests and number of man-hours required. He also plans foundries to meet given production requirements or modifies existing plans.

The Diploma examination papers and the scripts by the students are assessed by well-known experts in the industry and the Annual Reports of the School, giving details of the curriculum, lectures, visits and financial support, are available to all interested, and the Diploma examination papers are also available. Four papers are given at the Diploma examination in the three subjects of foundry metallurgy, foundry technology (equipment, methods, processes, materials, etc.), and foundry management (costing, estimating, organisation, administration, etc.). There are two other papers, to which the highest importance is attached. In one the student is usually offered the choice between an iron casting and a steel casting, and expected to produce a complete scheme of foundry production on the lines indicated above. In the remaining paper he is expected to choose similarly and deal with a non-ferrous casting, say, one in brass or one in aluminium. An alternative to one of these questions is a foundry lay-

GLANTON *for* TENSILES



Tensiles of 12-14 tons per sq. in. are regularly obtained on mixtures using Glanton as a basis.

Analysis

Graphitic Carbon %	Combined Carbon %	Total Carbon %	Silicon %	Sulphur %	Phos. %	Mang. %
3.35	0.35	3.7	2.0-3.5	.02-.04	0.5-0.75	0.7-1.0

Glanton can be confidently used for the general strengthening of all cupola mixtures at small cost. A series of mixtures using Glanton were made in an 18" Cupola to ascertain the strength which could be expected in the average foundry where high grade metal is required. Full particulars are available on application.

The Stanton Ironworks Company Limited, Near Nottingham

The largest producers of foundry pig iron for the free market in Great Britain.

out. Typical examination questions are detailed in Appendix II.

Ex-students of the School have an active body among themselves for maintaining social and professional contacts known as the Foundry Technical Group, which has its own officers, annual meeting, etc. Ex-students return to their employers, and in nearly all cases have been promoted to positions of responsibility in the foundry.

Firms who would like to send students to the School, but who do not have suitable candidates, are recommended to employ a suitably educated young man for an apprenticeship of from two to four years' duration. For a university man two years' apprenticeship may be regarded as adequate, but four years is necessary for a secondary school boy of, say, 17. The last year of this apprenticeship irrespective of its length should be spent at the School. Such apprentices may be ready for admission at 20. A scheme is briefly outlined in Appendix III, and ordinary apprenticeships can be modified on these lines for the more promising men.

It will be clear that since students taking the course return to their employers by prior arrangement, Foundry School students are not normally available for employment. Young men employed on an apprentice basis and desiring admission are recommended to complete their technical education to the standard required for admission by part-time study in the appropriate technical colleges. The problem of how they can be absorbed into the industry does not arise with students of the Foundry School.

The author is frequently approached by firms desiring to engage men for the industry, and in a high proportion of the cases the specification is that which could be filled by a diploma student of the Foundry School, i.e., a young man about 25 to 30 with some practical experience and sufficient technical knowledge to be able to deal with foundry problems, both of production and personnel. Of the people who might normally be considered, without the School training, they usually lack either the practical knowledge (such as chemists and other laboratory employees) or the technical knowledge (such as patternmakers and moulders), although a suitable man from either side might be capable of dealing with the work after a period at the School. The author believes in and uses the principle as far as possible of training and promoting men who prove themselves inside the organisation, although this, of course, by no means meets every case. In other words, the only way in which the industry can get trained men is to train them. This procedure will raise the numbers and quality of itself, because good men respond to the possibility of training and appreciate the standing of an industry in which training is regarded as important, and a greater choice of applicants is the result. The wider employment of trained men will help to promote the proper preparation of younger men.

Worshipful Company of Founders

It is impossible to conclude without reference to the recent proposal of the Worshipful Company of Founders, based on their conviction that the "development and progress of founding and the science of metallurgy must depend very largely on attracting to the industry highly trained men of outstanding talent." They propose to award a Fellowship of £250 per annum to men of character and initiative who have the scientific training usually associated with an honours degree. The selected candidate may do research, may spend a period in a works or may go abroad. As the fellowship is renewable for a second year, there will ordinarily be two fellowships in existence. This scheme will be welcomed by all who have the future well-being of the industry at heart, for it promises to be as broad-mindedly applied as it is carefully conceived.

Conclusion

Modern foundry training must be based on good general education for all grades of work and responsibility. It must comprise both practical experience and technical knowledge appropriately balanced for each grade. It must attract adequate numbers of workers both from the ranks and from higher educational institutions, and the industry must offer adequate incentive and possibility of promotion to men who prove to be of first-class calibre, irrespective of the level at which entering to the industry is made. Trained men can only be got by training, and the more difficult it becomes for foundries to do this themselves, the more important it becomes to make use of the institutions described.

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APPENDIX I

Institutions Supporting the British Foundry School

British Cast Iron Research Association.
British Non-Ferrous Metals Research Association.
City and Guilds of London Institute.
Institute of British Foundrymen.
Institution of Automobile Engineers.
Institution of Mechanical Engineers.
Iron and Steel Industrial Research Council of the British Iron and Steel Federation.
Iron and Steel Institute.
The National Light Castings Ironfounders' Federation.
Welsh Engineers' and Founders' Association.

APPENDIX II

Examination Papers for British Foundry School

The work on moulding and casting studies in iron, steel or non-ferrous metals is illustrated by a typical question, below, while one is also given on foundry design.

(1) Plan the production in grey cast iron of the housing casting shown. Ten castings are required, with a possibility of future small orders. The planning should be in accordance with the following schemes :—

(*a*) Calculate the weight of the casting, making suitable allowances for machining. Indicate the allowances you have made.
(*b*) Sketch and describe the pattern and core-boxes in detail, stating the material used in their manufacture.
(*c*) Design the moulding boxes to be used, including all details.
(*d*) Indicate the types of sand to be used for the mould and cores, giving the necessary test figures.
(*e*) Describe in detail the method of moulding, core-making and closing, and illustrate by sketches.
(*f*) Give the composition of the cast iron suitable for the casting. Explain why this particular composition has been chosen.
(*g*) Work out the mixture to be charged into a 4-ton per hr. cupola and indicate the melting losses.
(*h*) Estimate the total man-hours required per casting.
(*i*) Assuming some nominal values for cost of metal and overheads, work out the selling price.
(*j*) What modifications, if any, to the casting design would you suggest to aid production and produce sounder castings in future orders?

(2) A new non-ferrous foundry is to be built to take the place of an existing older shop. It is to use the existing pattern plates, patterns and boxes. The required output can be obtained with :—

12 squeeze machines (size of box part is 16 in. by 14 in. by 4 in. deep, production 80 boxes per man per day per machine).

12 hand-ram pattern draw machines (size of box part is 18 in. by 18 in. by 4½ in. deep, production 26 boxes per man per day per machine).

6 jolt machines (size of box part 24 in. by 21 in. by 5 in. deep, production 70 boxes per day per machine with 2 men per machine).

In addition to the area required for the above machines it will be necessary to provide about 1,000 sq. ft. for loose-pattern moulders.

For the melting plant a further space of approximately 500 sq. ft. should be provided.

Design a foundry to suit the above requirements, incorporating the following features :—

(*a*) Offices, foundry and pattern stores, laboratory.
(*b*) Mechanised sand plant to feed machines.
(*c*) Roller conveyor(s) to serve machines, and other handling appliances.
(*d*) Core shop suitable for about 12 core-makers (young persons).
(*e*) Stoves for oil sand cores and dry sand moulds.

APPENDIX III

Staff Apprenticeship

The existence of the Foundry School has brought home to some foundry managers and proprietors the fact that there is no systematic method of entry of better-educated young men into the industry, since they find they have no suitable candidates to send. In order to remedy this, the following suggestions are made, the common feature of which is the final year of apprenticeship at the Foundry School. Foundries differ so much in size and character, and posts differ in requirements and responsibility, that a rigorously defined system of entry is undesirable. The proposals are based on the foundry employing an apprentice with a view to training him for a staff post.

Graduates.—University graduates in metallurgy, engineering, or in some branch of applied science, form an admirable source of suitable men. These men will, in general, have no practical training except, possibly, vacation courses in works, and it is suggested that a two years' foundry apprenticeship should be arranged, of which ten months at the latter end of the period should be occupied by the normal Foundry School course, the remainder being spent in acquiring practical experience in as many types of work—moulding, coremaking, etc.—as the foundry offers. The experience should be made as broad as possible and opportunities offered to see the work of the drawing and design office, costing, planning, purchasing and other related departments, as well as machining, finishing and enamelling shops in works where these operations are pursued. Apprenticeship should not be limited to teaching manipulative and operative skill if executives are to be trained.

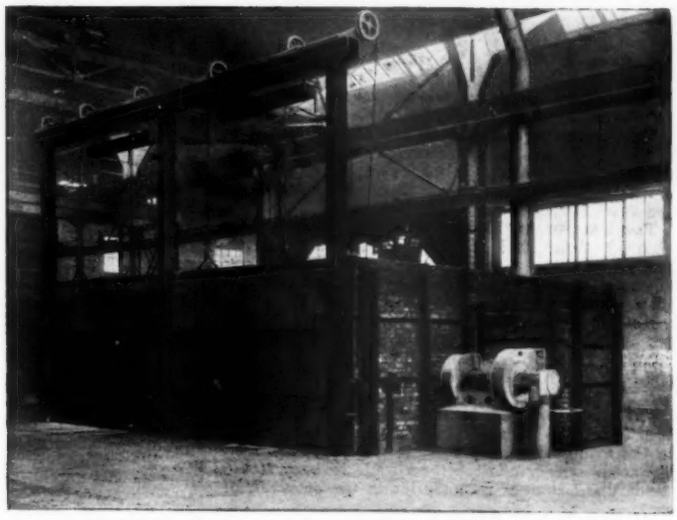
Secondary School and Public School Men.—These may be expected to be ready for entry between the ages of 16 and 18 and a four-year or five-year apprenticeship is suggested, ten months of which at the end of the course should be spent in the Foundry School. The age of entry to the latter should not be less than 20. Assuming that matriculation standard is reached at entrance, the early years of the apprenticeship should be spent in acquiring practical experience in the foundry and in part-time classes, to some extent in the day-time, leading to the ordinary national certificate and preferably higher national certificate in engineering, with as much metallurgy as possible. Two years should be adequate for the ordinary certificate, and the higher certificate could be taken prior to the Foundry School on a five-year apprenticeship.

Primary School Men.—An ordinary apprenticeship usually provides ample practical experience and part-time classes adequate technical knowledge, but experience has shown that good men may be sent to the Foundry School with profit up to 30 or over.

Engineering Apprentices.—Many firms have suitable courses of training for engineering apprentices on these lines, and it may well happen that a young man who has already started on such a course would be suitable, by test and inclination, for foundry work. Provided some practical engineering experience has been obtained, a year or eighteen months in the foundry would be adequate training prior to entry to the Foundry School. Apart from the training in foundry operations, apprenticeship is chiefly valuable in inculcating works discipline, in teaching ideas of the sequence of operations in production and in teaching the apprentice whether he is really suited to industrial work. From these points of view, engineering and foundry training may be regarded to some extent as interchangeable and, indeed, some time in machine and assembly shops where castings are machined and used is highly recommended for foundry apprentices.

Coke-fired Multiple Chamber Type Core Stove installed in a Motor Cycle Works. For core cracks 6′ × 3′ × 6′

Mould Drying Chamber installed in a works making colliery machinery using coke breeze fuel



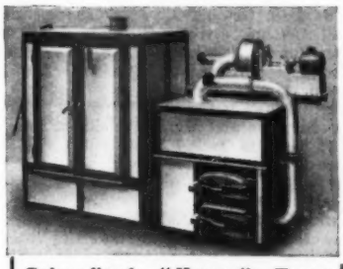
SANDBLASTING. The Airless "Sand Wizard" has reduced the cost of cleaning castings and descaling forgings, pressings, etc., by 80%.

COREMAKING. The Titan Core Machine is applicable to all types of cores and cuts labour costs by as much as 85%.

— AND NOW WE CAN OFFER LARGE ECONOMIES AND PERFECTION OF RESULTS IN CORE DRYING WITH OUR NEW - - -

TITAN CORE AND MOULD DRYING STOVES

- Uniformity of Temperature.
- Regulation 100° — 350°C ± 5°C.
- Automatic Regulation.
- No Burnt Cores.
- No Crusts or Cracks.
- No Distortion or Damage.
- Utmost Fuel Economy.
- Complete Range of Types.



Coke-fired "Korex" Tray Cabinet Stove. Core-plate area 85 sq. ft. May be extended to take a double cabinet

WRITE FOR FOLDER 203

We are now manufacturing the well-known Neustadter Core and Mould Drying Stoves. These stoves, which are widely used in Continental countries, have gained a high reputation for accurate regulation and uniformity of temperature and perfection of core-drying. We undertake the modernization of existing stoves.

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CHARGING SYSTEMS
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CORE MACHINES
CORE SAND MIXERS
SAND DRYERS
CORE AND MOULD OVENS, etc., etc.

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The Week's News in Brief

Trade Talk

BABCOCK & WILCOX, LIMITED, Renfrew, have received an order from Sheffield City Council for an electrically-operated overhead travelling crane for the Blackburn generating station.

THE ENTIRE organisation of Radiation, Limited, at Radiation House, 15, Grosvenor Place, London, including the research laboratories staff and the statistical department, has been transferred to Radiation House, Aston, Birmingham, 6.

THE BRITISH ALUMINIUM COMPANY, LIMITED, have removed their head office to the Raven Hotel, Castle Street, Shrewsbury, Salop (telephone: Shrewsbury 4451). All of the company's branch office addresses remain unchanged.

HOLMAN BROS., LIMITED, of Camborne, announce that all communications usually addressed to their London office at Broad Street House, E.C.2, should now be sent to "Glenwood," Heath Road, Potters Bar, Middlesex.

THE NORTHERN ALUMINIUM COMPANY announce that the price of their aluminium paste pigment for the manufacture of aluminium paint has not been advanced. Every effort will be made to keep to the standardised charges ruling prior to the outbreak of war.

WM. CUMMING & COMPANY, LIMITED, inform us that, as from October 1, their London address will be 26, College Drive, Ruislip, Middlesex (telephone: Ruislip 2390). Mr. E. A. Carlisle, their London representative, will, as hitherto, attend to all business matters.

IN THE FIRST HALF of 1939 metallurgical production in Bohemia and Moravia included 566,600 metric tons of pig-iron and 793,500 tons of steel ingots, compared with 697,900 tons and 992,300 tons, respectively, in the whole of Czechoslovakia in the first half of 1938.

THE British Iron and Steel Federation is continuing the compilation of statistical data relating to the iron and steel industry, but publication of the figures will be discontinued until further notice. It is understood, however, that there was a continued and pronounced increase in the output of steel during the month of August, after allowing for holiday interruptions. The industry has been working to capacity for a considerable time past and additional plant is being put into operation. The September production is therefore likely to reveal a substantial expansion.

THE Yawata Steelworks, which accounts for four-fifths of Japan's pig-iron output and controls several mines in China, in the Federated Malay States and in the Philippine Islands, recently contracted for additional ore supplies with producers in French Indo-China and in British India. The British Indian contracts involve a total of 250,000 metric tons, which are being delivered to Japanese bottoms at Calcutta and Mormagao. The ore is a hematite of 60-70 per cent. purity. This is the first Indian ore imported by Yawata. A shipment of 37,000 metric tons is expected shortly from French Indo-China.

THERE seems to be some doubt among contractors, firms and others, about the method by which priority is being enforced under the Priority of Work Order, 1939, made by the Minister of Supply. As stated in the JOURNAL last week, it is not the intention that priority shall be exercised over the whole field of industry. There will be no general issue of priority certificates in connection with Government work and such certificates will only be issued where difficulties arise between the competing demands arising from an immediate shortage or non-availability of production capacity, labour, raw materials, transport or any other cause. In the case of difficulties arising in the execution of a contract or order, contractors, firms, etc., should refer to the Government Department concerned in the issue of the order (or the appropriate Government Department in the case of civil industry). If necessity is proved, the appropriate Department will receive authority from the Ministry of Supply to issue priority certificates.

WILD-BARFIELD ELECTRIC FURNACES, LIMITED, have purchased land near Watford for the erection of a modern factory with facilities to enable the firm to handle their increased output and at the same time to improve deliveries. In due course, the entire organisation, comprising offices, works, research department and demonstration heat-treatment shop will be transferred to the new works. In the meantime, manufacture will continue at the present works at North Road, London, N.7, but temporary offices have been taken at 2-6, Highwood Avenue, Bushey, Herts, to which designs and drawing offices, accounts, sales and executive departments have been transferred. All correspondence should for the time being be addressed to these temporary offices. The associated company, G.W.B. Electric Furnaces, Limited, have also moved their registered offices, accounts, Eternite, and quenching-oil sales departments to the same address. Correspondence and inquiries relating to Gibbons-Wild-Barfield furnace designs, contracts, etc., should be addressed to Dibdale Works, Dudley, Worcs.

Replying to a question in the House of Commons last week, MR. BURGIN, Minister of Supply, said that all firms and Government factories engaged on munitions production had been asked to proceed on the basis of the utilisation of their full capacity. As existing orders were completed fresh orders were being placed with the utmost rapidity, and in the meantime firms had been instructed to proceed. Additional firms were being employed in accordance with allocations worked out in peacetime. Steps were being taken to expedite the construction of factories and plant and additional new factories were being undertaken. It was not intended to make certain firms controlled establishments in the sense in which that term was understood in the last war, but members would be aware of the powers of control conferred by the Ministry of Supply Act. The whole machinery of the Ministry of Supply was devoted to securing the maximum output in the minimum of time, and he had in hand certain reorganisations of, and additions to, the staff of the Ministry designed to facilitate the attainment of this object.

Personal

MR. WILLIAM J. STOREY, works and technical manager at Parkneuk Works of Alex. Findlay & Company, Limited, Motherwell, has been appointed to a similar position with the Cargo Fleet Iron Company, Limited.

MAJOR A. HIBBERT, general manager of the Millom & Askam Hematite Iron Company, Limited, has been appointed as district representative for iron ore control for Cumberland and Lancashire under the Ministry of Supply.

CAPT. R. S. HILTON has been appointed deputy chairman of the United Steel Companies, Limited. He has relinquished the appointment of managing director and Mr. C. J. Walsh, assistant managing director, has been appointed managing director.

MR. A. W. PERKINS has just retired after 37 years' service with Alfred Herbert, Limited, of Coventry. He went to the firm in 1902, as a draughtsman, and was appointed a year later assistant to the late Mr. T. Woof, in the sale of Herbert and factored machines in London and the South. In 1917 he was recalled to Coventry to take charge of the factored machine business, continuing this work until his appointment as manager of the Bristol office of the firm, seven years ago.

THE synopsis of a Paper entitled "The Anodic Oxidation of Aluminium," prepared for the Autumn Meeting of the Institute of Metals, which was to have been held in Glasgow, states that the anodic oxidation of aluminium in a number of different electrolytes using alternating-current electrolysis has been investigated with the aid of the cathode-ray oscillograph. The effect of the oxide barrier on the form of the current-time and current-voltage curves has been studied, and is shown to depend on the constitution of the electrolyte and operating conditions. Owing to a capacity effect, the current and voltage are always out of phase during the whole or a part of each half-cycle. The current-voltage curve consequently is a closed loop, the area of which is proportional to the dielectric loss in the film. The results obtained suggest that, while the mechanism of anodic oxidation in chromic, sulphuric, and oxalic acid baths is similar, chromic acid solutions should produce the more satisfactory films.

Obituary

MR. CHARLES WALTER LEATHER, who for over 40 years was connected with P. & C. Garnett, Limited, textile machinery makers and ironfounders, Wharfe Works, Cleckheaton, has died at Ilkley.

WE REGRET to announce the death of Mr. Charles M. Schwab, chairman of the Bethlehem Steel Corporation, who died in New York last Monday. The details of his meteoric rise to the position of the leading industrialist in the American iron and steel industry are well known. At 21 he was chief engineer of the Edgar Thomson Steel Works, and at 25 superintendent of the Homestead plant. In 1897, he assumed the mantle of Carnegie as President of the Carnegie Steel Company and later of the United States Steel Trust. He worked particularly assiduously for the Allied cause during the last war and refused what was perhaps the largest bribe ever offered to any individual to this end. He was a recipient of the Bessemer and Melchett medals. It was in 1902, consequent upon a newspaper interview with Mr. Schwab, that the then Editor of the FOUNDRY TRADE JOURNAL based his first leading article urging his readers to modernise in order to align themselves with alleged Continental developments.

Wills

PEGG, S. J., of Leicester, retired engineer and ironfounder	£28,268
LEIGHTON, A. F., of Walsall, director of A. S. Smith & Sons, malleable iron and brass founders and hardware manufacturers	£2,072

Company Reports

Vickers, Limited.—Interim dividend of 4 per cent.

Radiation, Limited.—No interim dividend on the ordinary shares.

A. Reyrolle & Company, Limited.—Interim dividend of 5 per cent.

British Insulated Cables, Limited.—Interim dividend on the ordinary shares of 5 per cent.

Blythe Colour Works, Limited.—Half-year's dividend on the 6 per cent. cumulative preference shares.

John Harper & Company, Limited.—Dividend on the redeemable preference shares at the rate of 7 per cent. per annum.

R. & W. Hawthorn Leslie & Company, Limited.—Final dividend of 7 per cent., making 10 per cent. for the year, to which is to be added a bonus of 2½ per cent., tax free.

Blakey's Boot Protectors, Limited.—Net profit for the year ended June 30 last, after providing for tax, £20,750; brought in, £15,989; ordinary dividend of 15 per cent.; carried forward, £23,212.

Contracts Open

Pretoria, November 10.—731 cooking stoves, for the Municipality. (D.O.T. reference: T. 26,865/39.)

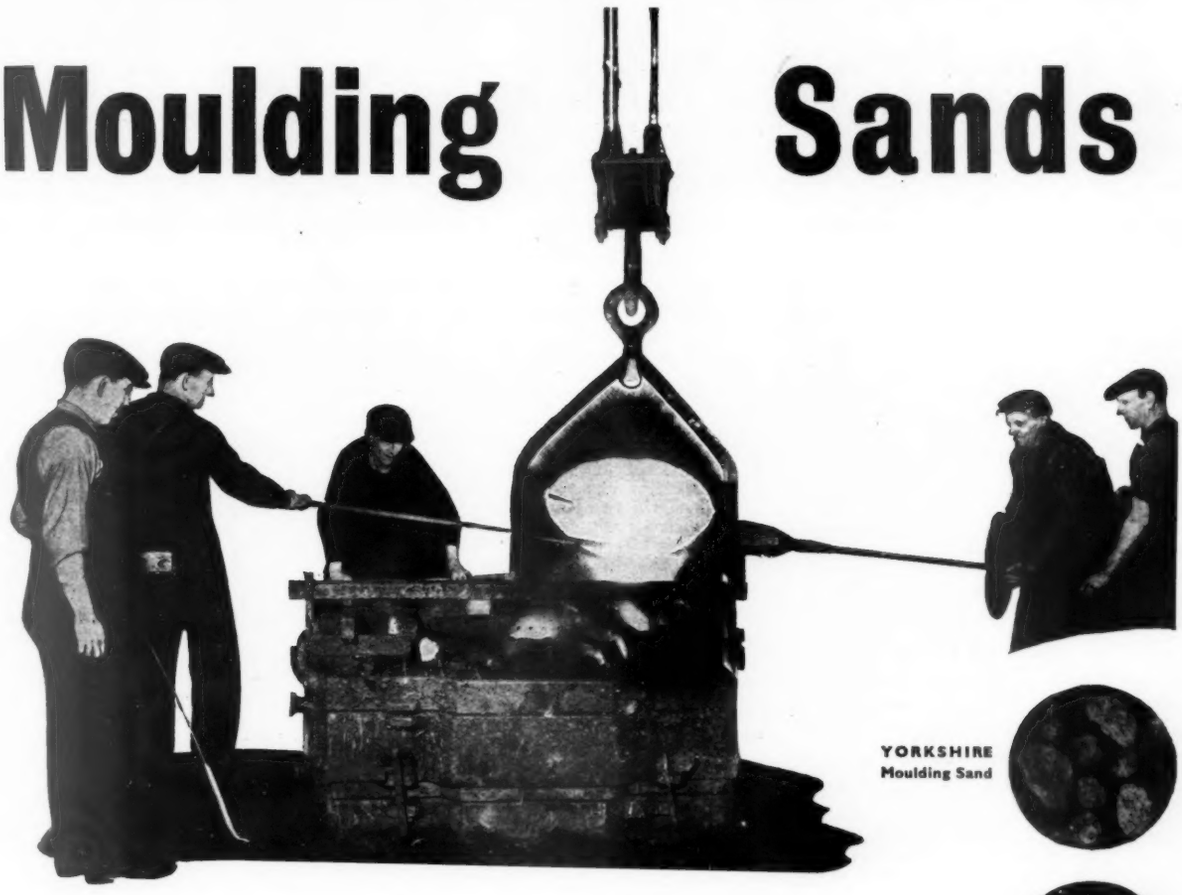
Cairo, October 9.—5,950 metres of cast-iron pipes, for the Director-General, Tanzim Department. The Inspecting Engineer to the Egyptian Government, 41, Tothill Street, London, S.W.1.

Leitrim, September 30.—Supply and erection of pumping plants, for the Leitrim Board of Health. Mr. P. H. McCarthy, consulting engineer, 26, Lower Leeson Street, Dublin.

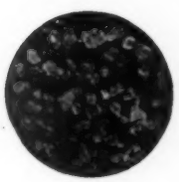
Johannesburg, November 6.—Boiler and superheater flue tubes and superheater elements, for the South African Railways and Harbours Administration. (D.O.T. reference: T. 26,976/39.)

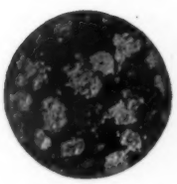
Johannesburg, October 14.—Supply and erection of pumping plant in duplicate, comprising two complete sets of electrically-driven, direct coupled, centrifugal pumps, motors and starters, for the City Council. The pumps must be of the double-entry, single stage, split-casing type, and each must be capable of delivering 1,000 Imperial galls. of water per min. to a height of 95 ft. above the point of suction. (D.O.T. reference: T. 26,974/39.)

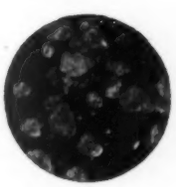
Moulding Sands



YORKSHIRE
Moulding Sand


THANET
Moulding Sand


YORK YELLOW
Moulding Sand


ZENITH
Moulding Sand

MANSFIELD
Moulding Sand

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Raw Material Markets

The iron and steel industry seems to be settling down quite satisfactorily following the new regulations resulting from State control. So far transport facilities have not assisted deliveries, but this position is improving, and it is to be hoped that commercial requirements of iron and steel will be met as far as possible when conditions are adjusted to meet the new demands.

Pig-Iron

MIDDLESBROUGH—The available supply of Cleveland foundry iron is more than sufficient to meet consumers' requirements, and new business is suspended meantime merely until the licensing system finds its feet. Although production of foundry iron has ceased, stocks, which are substantial, are likely to remain adequate for a considerable period. Local furnaces are, of course, engaged on the production of basic iron, which is passing to the steelworks in heavy tonnages. Deliveries of hematite have recently involved large supplies and the demand is at a high level.

LANCASHIRE—Jobbing foundries and light-castings makers are now better employed than they have been for a considerable time past, and the demand for foundry iron from these branches is steadily rising. Other consumers, notably heavy electrical engineers and machine-tool manufacturers, are also taking large contract deliveries. Business in hematite is active, and large tonnages are under requisition.

MIDLANDS—Firms engaged on defence work are naturally accounting for a considerable proportion of the iron consumed in this area, but where licences have been obtained makers are in the happy position of being able to despatch supplies promptly to ordinary users. This especially applies to high-phosphorus iron, stocks of which are plentiful. Low-phosphorus iron and hematite are being called for in increasing tonnages, mainly in connection with Government orders, for which no licences are required. Both high-phosphorus iron and hematite are controlled in price, but low-phosphorus iron quotations are still, as yet, without control, though in the near future both prices and distribution of this material may come within the compass of the Iron and Steel Control.

SCOTLAND—Substantial supplies of Indian and Australian iron are available in this area, in addition to which home production is at a good level. Consequently, consumers' needs are being easily met. Light-castings foundries are still quietly employed, but, with a considerable amount of Government work on hand, heavy ironfoundries are very well placed. Good deliveries of steelmaking iron are being made to local steelworks.

Coke

Supplies of foundry coke for the home market do not come within the licensing system and there has been a considerable volume of buying of late. Many consumers were already well covered ahead, but others have now entered the market for substantial tonnages. Producers, in many instances, have accepted business involving deliveries up to the end of the year at a firm figure of 50s. 6d. per ton, delivered Birmingham and Black Country stations, but this price is not now being quoted indefinitely for forward deliveries.

Steel

Deliveries of steel are now being made on a priority basis, Government work being given preference over civil projects. There is a very heavy demand for all descriptions of steel, structural material, bars, and plates being in especially strong request. Sheets continue to be absorbed in large tonnages for the production of air-raid shelters.

Scrap

The outbreak of hostilities has naturally reduced the imports of scrap and consequently there has been additional pressure for home-produced material. Steel scrap is particularly in request and steelworks are in the market for all they can acquire; control prices are, it is understood, being still maintained. As yet, no licences are required in connection with cast-iron scrap, but it is believed that a scheme is being prepared which will fix prices for this material.

Metals

A further increase in the tin quota for the third quarter of the year was announced by the International Tin Committee on Monday. The new quota will be 100 per cent. of standard tonnages. This is the fourth decision apropos the quota for the current quarter; in June the Committee fixed a level of 45 per cent., on September 1 the quota was raised to 60 per cent., while on September 12 a level of 80 per cent. was intimated. The announcement of the new quota was made before trading was resumed in tin on the London Metal Exchange. At the same time the Ministry of Supply made it known that the price of tin would be controlled at £230, and no dealings will be allowed above this figure. Of late tin quotations in the United States have risen to very high levels; Straits tin which, for example, is quoted in this country at slightly over £250 per ton, is now fetching over £300 in America. Thus it would seem that the higher quota for tin has been brought into being in order to bring the New York market down to more reasonable levels. The new regulations preclude resales of common tin at high premiums to the United States, while brand premiums will be considerably curtailed.

The quota of 100 per cent., which is the highest since the 110 per cent. quota in 1937, will, in theory, mean an addition to exports monthly of 3,470 tons to 17,330 tons, but every country will, of course, be unable to take the full advantage of the increase, and thus the actual increase in exports will be less. No further announcement has been made with regard to the quota for the final quarter of the year, which will be 60 per cent. unless a later decision is made.

An interesting statement to the Press was made by the American President recently. The Government, he said, would not permit commodity prices to sky-rocket as in the last war. Copper in particular could be produced at a big profit at 12½ cents per lb.

Owing to the war housing plans will no doubt fall away very substantially and, despite the unsatisfactory condition of the building industry during recent months, this will no doubt make available for more urgent uses very considerable tonnages of lead. The Ministry of Supply, it is understood, is keeping a watchful eye on industry's requirements of lead and copper; at present, new business can only be transacted if the consumer has obtained a licence authorising him to buy metal. If the user is unable to obtain his supplies from the Metal Exchange the Ministry is always willing to render assistance.

The Control of Aluminium Order, 1939, which has been summarised in previous issues, contains the following provisions with regard to prices:—

"No person shall buy or sell any virgin aluminium alloy situate in the United Kingdom on or at any time after this Order comes into force (*a*) at a price per ton exceeding £2 plus the value of the alloyed materials contained in one ton of alloy calculated at the prices per ton for each material specified in the Second Schedule hereto plus the value of the aluminium contained in one ton of alloy calculated at the prices per ton for aluminium ingot, aluminium rolling slabs or aluminium extrusion billets as the case may be, specified in the First Schedule hereto; or (*b*) in the case of any virgin aluminium alloy which at the date when this Order comes into force was normally sold under a registered trade mark, at a price per ton in excess of the price at which such alloy was sold immediately before the aforesaid date."

The maximum price laid down in the first schedule for virgin aluminium in the form of ingots is £94 per ton, basis, for 99 + per cent. material. This price is subject to the following increases:—99.5 per cent. guaranteed, £5; 99.6 per cent., £10; 99.7 per cent., £15; 99.8 per cent., £22; 99.9 per cent., £68; 99.99 per cent., £180. The increase for rolling slabs and extrusion billets is £3 per ton.

The prices of alloy materials in the second schedule, referred to above, are:—Silicon, £40; copper, £40; zinc, £20; magnesium, £200; nickel, £185; iron, £10; manganese, £150; tin, £200; chromium, £270.

High-Speed Twin-Drive Grinding Machine

(*Concluded from page* 195.)

When the wheel wears to such an extent that an increase in speed is justified, the wheel automatically stops and cannot be re-started until the necessary change has been made, thus avoiding a gap between the wheel and the rest, which is dangerous to the operator. This is effected by a limit switch which is tripped when the work rest approaches one of its three relative positions, as shown in Fig. 1. This switch being connected in the starter circuit immediately cuts out the motor. By using the conveniently placed speed-change handle the next higher speed is engaged and the limit switch automatically moves clear, permitting the motor to be re-started immediately.

The guards, which are of special design to comply with Home Office regulations, are of substantial construction in fabricated steel, and fitted with high-tensile steel bolts. They are adjustable for wheel wear and have a hinged side door for wheel replacement. The guards are bolted down to extensions on the main body casting and none of the fastening bolts is in shear.

One of the work rests is shown in Fig. 1; these are substantial iron castings, having the working surface chilled hard to resist wear and reduce friction. The rests are mounted on arms which can be readily adjusted for height as required.

Special attention has been given to the question of dust extraction, since when the high-speed type of grinding wheel is used a higher degree of efficiency and a greater volume of air than formerly are necessary to cover the modern Factories Act Regulations, and a self-contained unit fitted with a motor-driven fan containing a fabric filter within a totally-enclosed case is employed.

The leading dimensions of the machine illustrated, which has 24-in. dia. by 3-in. face by 8-in. bore grinding wheels, are as follow: Washer plates, 12 in. diameter; speeds, 1,512, 1,814 and 2,268 r.p.m. for wheel diameters of 24 in., 20 in., and 16 in.; wheel bearings, 3 in.; height from floor to wheel centres, 2 ft. 9 in.; two motors each of 5 h.p. The floor space occupied by the machine is 5 ft. 3 in. by 4 ft., and the weight is 27 cwts. The capacity of the dust-exhaust equipment is 800 cub. ft. per min.

THE directors of the United Steel Companies, Limited, recommend a final dividend on the stock of the company of 5½ per cent., less income tax, making with the interim dividend already paid a total of 8 per cent. for the year ended June 30, 1939, payable on October 12, to holders on the register at the close of business on September 28.

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